NASA News

National Aeronautics and Space Administration

Washington, D.C. 20546
AC 202-453-8400

For Release:

July 6, 1989
2:00 p.m. EDT

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Headquarters, Washington, D.C.
(Phone: 202/453-8536)

Dom Amatore
Marshall Space Flight Center, Huntsville, Ala.
(Phone: 205/544-0034)

RELEASE: 89-108

LEE APPOINTED DIRECTOR OF MARSHALL SPACE FLIGHT CENTER

NASA Administrator Richard H. Truly today announced the appointment of Thomas J. (Jack) Lee to be Director of the Marshall Space Flight Center, Huntsville, Ala., effective immediately.

Lee, 54, succeeds James R. Thompson, Jr., who was selected by President Bush to be the NASA Deputy Administrator.

Lee has been the Marshall Center's Deputy Director since December 1980, after 7 years as manager of the Spacelab program at the center. From July to September 1986, he served as Acting Director of the center.

In addition to his responsibilities as Deputy Director, Lee has served as Manager of the Heavy Lift Launch Vehicle Definition Office, which is leading NASA's efforts to define and develop a heavy lift launch vehicle capable of meeting national requirements.

As Marshall Center Director, Lee is charged with overall management of one of the largest and most diversified of the NASA field centers. The center, with 3,500 employees, has responsiblity for the design and development of space transportation systems, orbital systems, scientific and applications payloads, and other projects for present and future space exploration, research and commercial developments.

- more -

Lee began his professional career in 1958 as an aeronautical research engineer with the U.S. Army's Ballistic Missile Agency at Redstone Arsenal, Ala. He transferred to the Marshall center when it was formed in 1960 as a systems engineer with the center's Centaur Resident Manager Office located in San Diego, Calif. From 1963 to 1965, he was Resident Project Manager for the Pegasus Meteoroid Detection Satellite Project, Blandenburg, Md., and, from 1965 to 1969, was Chief of the center's Saturn Program Resident Office at the Kennedy Space Center, Fla. In 1969, he became Assistant to the Technical Deputy Director of the Marshall Center and served in that position until 1973. He then served as Deputy Manager and Manager of the Sortie Lab Task Team, and continued as Manager when that team became the Spacelab Program Office in 1974.

As Manager of the Spacelab Program Office, he was responsible for NASA's work with the European Space Agency in the development of Spacelab, a multipurpose reusable laboratory for Earth orbital science activities.

Lee was awarded the NASA Exceptional Service Medal in 1973, the NASA Distinguished Service Medal in 1984 and in 1988, the Presidential Rank of Meritorious Executive.

He is an Associate Fellow of the American Institute of Aeronautics and Astronautics and a registered professional engineer.

A native of Wedowee, Ala., Lee studied aeronautical engineering at the University of Alabama, receiving his bachelor of science degree in 1958. In 1985, he completed the Advanced Management Program at the Harvard School of Business.

Lee and his wife, the former Jean Manning of Scottsboro, Ala., live near New Market, Ala., and have two children, Kevin and Patrick.

- end -

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For Release:

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July 6, 1989

Mary Ann Peto
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RELEASE: 89-109

HARRIS CORP. SELECTED FOR ADVANCED COMMUNICATIONS TECHNOLOGY WORK

NASA Lewis Research Center, Cleveland, today announced the selection of the Harris Corp., Melbourne, Fla., for final negotiations leading to award of a contract to develop a prototype Earth station for use with the Advanced Communications Technology Satellite (ACTS).

ACTS is a key element in NASA's efforts to develop high-risk, advanced communications technology usable in the higher frequency bands to support our nation's future communications needs. Realization of this goal will enable the U.S. to maintain preeminence in satellite communications.

The prototype unit will be developed on the basis of cost-plus-incentive-fee. The contract will become effective in late summer and last approximately 24 months. The contractor-proposed price is $3.4 million for the prototype development.

The proposed Earth station will have the capability for multichannel voice and data services at data rates up to 1.544 megabits per second. The prototype unit will be designed so that additional units can be built at low cost for the ACTS experiment program. The anticipated contract will include options for the procurement of additional low-cost units, depending upon the future needs of the ACTS experiment program.

ACTS is under development for launch from the Shuttle in May 1992 for a planned 2-year experiments mission. The ACTS system will be made available to the public and private sectors (corporations, universities and government agencies) for experimentation. Experimenters will test, evaluate and determine the feasibility of key ACTS system technologies.

Work on the prototype Earth station will be performed at the contractor's plant in Palm Bay, Fla.

\- end -

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For Release:

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July 7, 1989

RELEASE: 89-111

BALLHAUS RESIGNS AS DIRECTOR OF NASA'S AMES RESEARCH CENTER

Dr. William F. Ballhaus, Jr., has resigned as Director of NASA's Ames Research Center, Mountain View, Calif., effective July 15.

Ballhaus served as Director of the center from January 1984 through January 1988 and from February 1989 until the present. As Director, he was responsible for all research and development programs and the overall management of Ames and the Ames-Dryden Flight Research Facility, Edwards Air Force Base, Calif. Ames and Ames-Dryden, which together have more than 5,000 employees, conduct research and development programs in the fields of aeronautics, life science, space science, space technology and flight research.

Ballhaus also served as Acting Associate Administrator for Aeronautics and Space Technology, NASA Headquarters, Washington, D.C., from February 1988 through March 1989. In this temporary position, he was responsible for direction of NASA's aeronautics and space technology programs, as well as the institutional management of NASA's Ames, Langley and Lewis research centers.

Citing inadequate compensation for senior federal executives and vague new post-government employment regulations as factors in his decision, Ballhaus expressed regret at leaving federal service. "It has been a privilege to have worked for NASA for the last 18 years. I will miss the agency and the many outstanding people with whom I have shared so many wonderful experiences," he said. "It is a terrific organization and will be an exciting place to be under Dick Truly's outstanding leadership; however, my family situation is such that public service in the current environment is no longer a viable option for me."

- more -

Ballhaus began his NASA career in 1971 at NASA Ames in the Computational Fluid Dynamics Branch. In 1979, he became Chief of the Applied Computational Aerodynamics Branch. He served as Director of Astronautics for the center from 1980 through 1984.

Throughout his career, Ballhaus has received many distinguished awards, including: the Presidential Rank of Distinguished Executive, the Presidential Rank of Meritorious Executive, the Senior Executive Association's Distinguished Executive Service Award and the American Institute of Aeronautics and Astronautics (AIAA) Lawrence Sperry Award for his pioneering work in numerical methods and computer codes for predicting transonic flow fields about aerodynamic configurations.

Ballhaus recently completed a 1-year term as President of the AIAA. He is a Fellow of the AIAA and the Royal Aeronautical Society and has been elected to the National Academy of Engineering and the International Academy of Astronautics. He serves on advisory boards for a number of academic and research institutions.

An honors graduate of the University of California at Berkeley, Ballhaus received his B.S. in mechanical engineering in 1967, M.S. in mechanical engineering in 1968 and Ph.D. in engineering in 1971. He served in the U.S. Army Reserve from 1968 to 1976, achieving the rank of Captain.

A Los Angeles native, Ballhaus is married to the former Jane Kerber. They have four children.

- end -

NASA News

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For Release:

July 7, 1989

RELEASE: 89-112

NASA, CANADIANS TO FLY PLASMA EXPERIMENT ON OMV MISSION

NASA is planning to fly a Canadian experiment to measure the behavior of radio waves in space and properties of the upper atmosphere, the ionosphere, during the demonstration flight of the Orbital Maneuvering Vehicle (OMV), according to a proposal recently agreed to by the Canadian Space Agency.

The ionosphere layer causes reflection of shortwave radio signals and therefore, allows global communications. It also is the region that first begins to filter solar radiation that could be harmful to life on Earth.

The maiden voyage of the OMV, a remotely controlled, reusable "space tug" designed to perform a number of tasks including maneuvering other spacecraft on orbit, is currently scheduled for launch aboard the Space Shuttle Endeavour in 1993.

Its payload will be a 3-part, high-frequency radio wave experiment called Waves in Space Plasma (WISP-HF). Developed by the National Research Council of Canada, the experiment will measure the interaction of an antenna with the tenuous upper atmosphere that has been transformed into a plasma -- a gas of charged particles -- by sunlight. This layer is called the ionosphere.

This interaction will be measured close to the antenna. WISP-HF will study the propagation of radio waves through the ionosphere within a few miles or so of the antenna and then make measurements with the OMV up to 60 miles from the orbiter to clarify the scale structure and behavior of the ionosphere.

- more -

WISP-HF is the high-frequency portion of a collaborative U.S.-Canadian investigation that was scheduled to be flown on one of the first space plasma laboratory missions in the 1990s. These missions were delayed due to the Challenger accident. Flight of the WISP-HF hardware on the OMV-1 mission will accomplish many of the original science objectives while requiring only limited modification to the hardware.

By operating the transmitter at heights near the maximum density of the ionosphere, radio waves will be sent directly or bounced between the orbiter and WISP/HF receiver aboard OMV-1. Instruments aboard the orbiter and OMV-1 will monitor disturbances in ionospheric plasma.

The WISP-HF equipment will generate, receive and process signals in the 0.1- to 30-MHz range. The orbiter-based transmitter will have variable pulse-power levels up to 500 watts and will use a dipole antenna, 164 feet tip-to-tip.

WISP-HF receivers will be located both on the orbiter and on OMV-1. During its checkout, the OMV-1, remotely controlled from the ground, will be flown as far from the orbiter as 60 miles.

The OMV project, WISP-HF mission integration and hardware for integrating the WISP-HF to the OMV-1 will be managed at the Marshall Space Flight Center, Huntsville, Ala.

- end -

NASA News

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For Release:
July 10, 1989

RELEASE: 89-113

NASA AND GERMAN MINISTRY SIGN SPACE TRANSPORTATION AGREEMENT

Richard H. Truly, NASA Administrator, and Heinz Riesenhuber, Federal Minister for Research and Technology of the Federal Republic of Germany, today signed a memorandum of understanding in Washington, D.C., enabling the launch of German payloads on the Space Shuttle.

This agreement confirms general understandings for the terms and conditions under which NASA will furnish launch and associated services on a reimbursable basis consistent with U.S. and German space policy. Under the MOU, specific launch services agreements or other agreements will be signed for each activity.

The first flight will be the D-2 Spacelab mission, currently scheduled for launch in February 1992. It will carry German materials processing and life sciences experiments and a small number of NASA experiments. The crew will include two German payload specialists. The Federal Republic of Germany (FRG) has paid earnest money to NASA for an additional mission, the D-3 Spacelab, currently scheduled for launch in November 1993.

Under a similar agreement signed in April 1981, the FRG's D-1 Spacelab mission was successfully completed in November 1985. The D-1 mission carried materials processing and life sciences experiments. The crew included two German and one Dutch payload specialists.

FRG has long been a supporter of Space Transportation System utilization and contributed 40 percent to the European Space Agency development of the Spacelab. FRG, as a member of the European Space Agency, will also contribute significantly to the development of the Space Station Freedom.

- end -

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For Release

Mary L. Sandy
NASA Headquarters, Washington, D.C.
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July 12, 1989

H. Keith Henry
Langley Research Center, Hampton, Va.
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N89-51

EDITORS NOTE: AIRCRAFT/HEAVY-RAIN BRIEFING/DEMONSTRATION SET

A briefing for news media will be held July 24 at NASA's Langley Research Center, Hampton, Va., on preliminary results from a series of NASA tests that indicate heavy rain may reduce aircraft wing performance when it is most needed - during landing approach or takeoff in the presence of a microburst storm. NASA's heavy rain research is part of the NASA-FAA airborne wind shear detection and avoidance program.

Microbursts, the most dangerous type of wind shear, are small, intense downdrafts which, upon striking the ground, spread out into a circular vortex, radiating in all directions. When microbursts are encountered during approach or takeoff, pilots usually have little time to react to maintain the desired flight path. Between 1964 and 1985, there were at least 26 accidents involving 500 fatalities and more than 200 injuries where wind shear was the direct cause or a contributing factor.

Understanding heavy rain is important to the study of wind shear. In cases where greater than usual lift is required of an aircraft wing, as in a low-altitude encounter with wind shear, heavy rain may reduce wing performance when it is most needed. Modern wings rely on smooth, uninterrupted flow of air across wing surfaces for maximum wing performance. Wind tunnel tests suggest that heavy rain disrupts wing airflow.

The briefing will be held in Building 1261 at 9:30 a.m. A demonstration will take place shortly after the briefing. Researchers will be available for individual interviews after the demonstration.

The demonstration tests will be visually dramatic. Please note that it may require more than one camera to adequately record this high-speed event. A news release, video and photographs will be available.

- end -

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RELEASE: 89-116

NASA EXHIBIT AT EAA FOCUSES ON "INVESTING IN THE FUTURE"

NASA returns to Oshkosh, Wisc., July 28-August 3, as a main exhibitor at the 37th Annual Experimental Aircraft Association International Fly-In Convention and Sport Aviation Exhibition. This year's exhibit, "Investing in the Future," will emphasize how the United States benefits from NASA's leadership in aeronautics, space science and exploration.

In the aeronautics area, visitors will see how NASA scientists, engineers and craftsmen are working to make the aircraft of tomorrow safer, faster and more efficient.

Visitors also will learn about high-speed research and technology projects that will enable commercial airliners to travel from Los Angeles to Tokyo in less than four hours.

Plans include the exhibition of an 80-foot half-scale mockup of the National Aero-Space Plane built by engineering students at Virginia Polytechnic Institute and State University, Blacksburg, Va.

The National Aero-Space Plane program, a joint NASA and Department of Defense effort, is developing the technology for a single-stage-to-orbit vehicle capable of taking off and landing on airport runways, accelerating to orbital speeds (Mach 25) and flying at sustained hypersonic speeds (up to Mach 12) within the atmosphere.

The vision for the 21st century is a family of reusable, economical aero-space vehicles for rapid, long-distance, intercontinental transportation as well as easy access to Earth orbit.

- more -

A 7-foot model of the X-29 forward-swept wing, supersonic research aircraft will be exhibited. The first X-29 flew 242 technology-proving missions and a second X-29 is being tested for maneuverability.

Aircraft safety improvements will be featured. The exhibit showcases NASA technology designed to help pilots avoid collisions, make critical takeoff decisions, detect and correct engine problems and overcome weather hazards such as wind shear, heavy rain and icing.

Engineers from the Langley Research Center, Hampton, Va., have added a vortex flap to the front of the wing of an F-106 aircraft to reduce drag and increase aircraft lift. This concept, which will be on display, promises to increase the maneuverability of swept-wing aircraft by 20 percent.

Also on display will be revolutionary new engine, wing and fuselage designs being tested to make the aircraft of tomorrow more maneuverable and fuel efficient.

Visitors can examine a scale model of a Mach 5 aircraft engine inlet model that recently underwent wind tunnel tests at Lewis Research Center, Cleveland. The tests were focused on validating computational codes used to analyze the inlet's performance. The work will have application for the next generation of high-speed transports, including the National Aero-Space Plane and trans-atmospheric military vehicles.

In the 20 years since man first stepped on the moon, NASA has taken bold strides toward even greater achievements in space science and exploration. In addition to launching three major space science missions this year, NASA stands on the brink of establishing a permanent manned presence in space aboard Space Station Freedom.

At the NASA exhibit, visitors can learn more about Space Station Freedom and this year's three major space exploration projects -- the Hubble Space Telescope, the Magellan mission to Venus and the Galileo mission to Jupiter. Models of the Hubble Space Telescope and Space Station Freedom will be available for inspection.

The exhibit also describes the Pathfinder Program which is developing technology for possible 21st century missions such as a manned outpost on the moon or robotic or manned exploration of Mars.

The U.S. investment in aeronautics and space research has paid enormous dividends on Earth. For example, NASA-developed technology has been successfully adapted for more than 30,000 "spinoff" applications here on Earth. The NASA exhibit highlights some of these spinoffs which have enriched the nation's economy and improved our daily well-being.

One of the most popular displays, the NASA craftsmanship exhibit, returns this year. Operated by technicians from the Langley Research Center, Hampton, Va.; Lewis Research Center, Cleveland; and Ames Research Center, Mountainview, Calif., the exhibit highlights fabrication crafts and focuses on selected examples of metal and composite structures, aeronautical models, test equipment and data measurement hardware.

A variety of live and taped programs will be presented daily in the mini-theater. Outside the exhibit building will be the AEROVAN traveling aeronautics exhibit and the SARSAT van, a mobile exhibit that presents an overview of the Search and Rescue Satellite system.

More than 2 dozen NASA speakers will conduct technical forums throughout the convention on subjects ranging from "How to Measure Angle of Attack" to "Aircraft De-Icing Systems."

Education Specialists will be on-hand to inform teachers of the many services available to them through the Teacher Resource Center Network and Educational Services Offices.

-end-

NOTE TO EDITORS:

To reach a NASA public affairs representative at the EAA Convention, phone 414/235-5424. AEROVAN and SARSAT van spokespersons will be available for interviews during exhibit hours at their respective mobile exhibit vans in front of the NASA Exhibit Building.

NASA News

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For Release
July 13, 1989

RELEASE: 89-117

APOLLO-ERA TECHNOLOGY SPINOFFS CONTINUE TO ENHANCE HUMAN LIFE

Twenty years after the triumph of America's first lunar landing, the technologies developed to enable manned spaceflights and exploration of the moon continue to enhance human life here on Earth through technology spinoffs to the fields of health, safety, comfort and enjoyment of life.

The achievement of the national commitment to land U.S. astronauts on the moon and return them safely to Earth spurred major advances in emerging technologies, such as computers, which became smaller, lighter, and more efficient to meet the requirements for manned spacecraft.

Some specific examples of everyday products that employ technology from the Apollo program:

* The lunar roving vehicle, developed for use by the Apollo astronauts to venture several miles away from their landing base, was the source of a unistix controller now used by severely handicapped people to accelerate, brake and steer a typical passenger vehicle on the highway. The vehicle's rubber tires, which had to have low temperature pliability, were developed for NASA by Goodyear, which used the technology to produce an all-weather winter radial tire for use on automobiles.

* Scratch resistant sunglass lenses were derived from a highly abrasion-resistant coating developed to protect, from harsh environments, the plastic surfaces of aerospace equipment like the helmet visors worn by moon-walking astronauts.

* A collection of cordless tools -- such as drills and dust vacuums -- were derived from tools developed for the astronauts to use on the moon while collecting surface and subsurface lunar soil samples.

- more -

• Patient monitoring equipment, commonly used today at nurses stations to monitor the heart rate and other physiological signs of hospital patients, employs the same technology that was developed to monitor astronaut vital signs during spaceflight.

* A special fabric developed for Apollo spacesuits, with the qualities of being thin, light, flexible, yet durable and non-combustible, provided the technology basis for heavier material used for constructing fabric roofs on structures like Michigan's silverdome.

* For moonwalking safety and comfort, the Apollo astronauts wore lunar boots which featured a three-dimensional "spacer " material for cushioning and ventilation. The material has been modified for use today in a popular line of athletic shoes designed for improved shock absorption and reduced foot fatigue.

* Hundreds of lives have been saved through a widely used commercial raft that will not capsize in heavy seas. The raft employs a NASA-patented water ballast stabilization system used in rafts developed for the returning Apollo astronauts after their splashdown.

* An electrical power controller, developed for use on the Saturn rocket to conserve energy, has been widely used to reduce energy consumption in electrical motors.

* A 3M-designed, meal-heating unit developed for Apollo spacecraft crews served as the basis for an electronic food warming system used in hospitals.

* The inorganic coatings developed to provide corrosion protection to the seaside launch gantries used for Apollo-Saturn missions have seen widespread industrial use on coastal and ocean structures such as bridges, pipelines, ships and oil rigs.

* Insulation technology developed for the Saturn V booster fuel tanks by Rockwell International provided an improved insulation for the wells holding fresh-caught fish on tuna boats.

These are but a few of the spinoffs, estimated to number in the thousands, which can be traced directly to the technology that launched and landed Americans on the moon in July 1969.

- end -

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For Release:
July 17, 1989

RELEASE: 89-119

APOLLO-11 LUNAR EXPERIMENT STILL USEFUL AFTER 20 YEARS

An experiment placed on the lunar surface 20 years ago by the Apollo 11 astronauts continues to be used to study the Earth-moon system by NASA's Jet Propulsion Laboratory, Pasadena, Calif., and other scientific centers around the world.

Scientists, who analyzed the data from the Laser Ranging Retro-reflector Experiment, have observed, among other things, that the moon is moving away from the Earth, tectonic plates of the Earth are slowly drifting and the length of a day varies.

The Laser Ranging Retro-reflector was designed to reflect pulses of laser light fired from the Earth. The idea was to determine the round-trip travel time of a laser pulse from the Earth to the moon and back again, thereby calculating the distance between the two bodies to unprecedented accuracy. Unlike the other scientific experiments left on the moon, this reflector requires no power and is still functioning perfectly after 20 years.

The laser reflector consists of 100 fused silica half cubes, called corner cubes, mounted in an 18-inch square aluminum panel. Each corner cube is 1.5 inches in diameter. Corner cubes reflect a beam of light directly back toward the point of origin. It is this fact that makes them so useful in Earth surveying.

The McDonald Observatory, Ft. Davis, Texas; the Lure Observatory atop the extinct Haleakala volcano on the island of Maui, Hawaii; and a third observatory in southern France near Grasse, regularly send a laser beam through an optical telescope and try to hit one of the reflectors.

- more -

The reflectors are too small to be seen from Earth, so even when the beam is correctly aligned in the telescope, actually hitting a lunar reflector is quite challenging. At the moon's surface, the beam is roughly a mile wide and scientists liken the task of properly aiming the beam to using a rifle to hit a moving dime 2 miles away.

Once the laser beam hits a reflector, scientists at the observatories use sensitive filtering and amplification equipment to detect the return signal. The reflected light is too weak to be seen with the human eye, but under good conditions, one photon -- the fundamental particle of light -- will be received every few seconds.

Three more reflectors have since been left on the moon, including two by later Apollo missions and one by the unmanned Soviet Lunakhod 2 lander. Each of the reflectors rest on the lunar surface in such a way that its flat face points toward the Earth.

Continuing improvements in lasers and electronics over the years have led to measurements accurate to approximately 1 inch. Scientists know the average distance between the centers of the Earth and the moon is 239,000 miles, implying that the modern lunar ranges have relative accuracies of better than one part in 10 billion. This level of accuracy represents one of the most precise distance measurements ever made and is equivalent to determining the distance between Los Angeles and New York to one fiftieth of an inch.

During the last 20 years, scientists have used the orbit of the moon and the lunar ranging sites to study events on Earth. Lunar ranging has contributed to several scientific advances:

* Lunar ranging has helped determine the precise positions of the observatories that send the laser beams. Using these positions, scientists can tell that the tectonic plates of the Earth's crust are slowly drifting and the observatory on Maui is seen to be moving away from the one in Texas.

* The atmosphere, tides and the core of the Earth cause changes in the length of an Earth day -- the variations are about one thousandth of a second over the course of a year.

* The familiar ocean tides raised on the Earth by the moon have a direct influence on the moon's orbit. Laser ranging has shown that the moon is receding from the Earth at about 1.5 inches every year.

- more -

* Lunar ranging, together with laser ranging to artificial Earth satellites, has revealed a small but constant change in the shape of the Earth. The land masses are gradually changing after being compressed by the great weight of the glaciers in the last Ice Age.

* Predictions of Einstein's Theory of Relativity have been confirmed using laser ranging.

* Small-scale variations in the moon's rotation have been measured. They result from irregularities in the lunar gravity field, from changes in the moon's shape due to tides raised in the moon's solid body by the Earth and possibly from the effects of a fluid lunar core.

* The combined mass of the Earth and moon has been determined to one part in 100 million.

* Lunar ranging has yielded an enormous improvement in knowledge of the moon's orbit, enough to permit accurate analyses of solar eclipses as far back as 1400 B.C.

The usefulness of continued improvements in range determinations to further advance understanding of the Earth-moon system and the need for monitoring details of the Earth's rotation will keep the lunar reflectors in service for years to come.

Lunar ranging analysis at JPL is undertaken by Drs. Jean Dickey, James G. Williams and X X Newhall and is sponsored by the Geodynamics Branch of NASA's Office of Space Science and Applications. Additional analysis is accomplished at the Harvard/Smithsonian Center for Astrophysics and the Massachusetts Institute of Technology, both in Cambridge, Mass.; at the University of Texas, Austin; and in France and China.

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EDITORS NOTE: A 4-minute, 38-second video clip supporting this press release is available from NASA by calling 202/453-8594.

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For Release

Edward Campion
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July 18, 1989

RELEASE: 89-118

NASA AWARDS GRANTS FOR FUTURE EXPLORATION STUDIES

NASA's Office of Exploration has awarded a series of study contracts to various organizations to provide NASA with ideas, concepts, devices, systems, trajectories, operations or implementations which could be applied to furthering human exploration of the solar system.

The 20 winners, selected from 115 proposals submitted in response to the April 12, 1989, NASA Research Announcement, are located in 12 different states and come from various occupations with five industry-related firms, two space support-related organizations and 13 universities receiving awards.

In selecting the winners, the criteria applied to all the submissions was the experience of the principal investigator, the relevance of the proposal to programs of human exploration of the solar system, the performance improvement or complexity reduction possibilities and the uniqueness of the idea or concept.

Space Support-Related Organization Winners

o Oregon L-5 Society, Inc., Oregon City, Ore. - "Site Characterization of the Oregon Moonbase."

o Tether Applications, La Jolla, Calif. - "Preliminary Design of a 1KM/SEC Tether Transport Node."

Industry-Related Winners

o Martin Marietta Strategic Systems, Denver, Colo. - "Study of Nuclear Thermal Rockets Utilizing Indigenous Martian Propellants."

o Dean & Associates, Alexandria, Va. - "An Early Warning System for Monitoring Large Projects."

- more -

o Titan Systems, Inc., San Diego, Calif. - The Evolution of Design Alternatives for the Exploration of Mars by Balloon."

o Engineering Development Laboratory, Inc., Newport News, Va. - "Determination of the Concentration of Spacecraft Cabin Gases using Laser Spectroscopy."

o Orbitec, Madison, Wis. - "Aluminum/Oxygen Rocket Engine for Lunar Transport Applications" and "The Use of Tethered Platforms to Recover, Store, and Utilize CO_2 from the Mars Atmosphere for On-Orbit Propellants."

University-Related Winners

o Energy & Mineral Research Center, Grand Forks, N.D. - "Further Investigation of the Feasibility of Applying Low-Temperature Plasma Technology to a Closed-Loop Processing Resource Management System."

o Texas Engineering Experiment Station, College Station, Texas - "Design of a General Purpose, Mobile, Multifunctional Radiation Shield for Space Exploration."

o Boston College, Chestnut Hill, Mass. - "Design Considerations of a Lunar Production Plant."

o Michigan Technological University, Houghton, Mich. - "Planetary Materials and Resource Utilization."

o The Regents of the University of California, Santa Barbara, Calif. - "A Small Particle Catalytic Thermal Reactor (SPCTR) for the Conversion of CO and CO_2 to Methane in a Gravity-Free Environment Vehicle."

o The University of Michigan, Ann Arbor, Mich. - "Advanced Fuel Cycles for the MICF - Fusion Propulsion System."

o Boston University, Boston, Mass. - "Pneumatic Structures for Lunar and Martian Habitats."

o State University of New York at Stony Brook, Stony Brook, N.Y. - "Artificial Intelligence to Simulate the Green Thumb."

o The Regents of the University of Colorado, Boulder, Colo. - "Mars Tethered Sample Return Study."

o The University of New Mexico, Albuquerque, N.M. - "Teleprospector: A Teleoperated Robotic Field Geologist."

o Duke University, Durham, N.C. - "Deployable Magnetic Radiation Shields using High Tc Superconductors: A New Concept."

- more -

o International Space University, Boston, Mass. - "International Lunar Polar Orbiter (ILPO)."

o The University of Texas, Houston, Texas - "Emergency Surgery and Surgical Critical Care to Support Human Exploration of the Solar System."

The Office of Exploration intends to follow these selections with future solicitations for other innovative ideas and concepts. These follow-on studies could be to refine concepts studied this year or to deepen NASA's understanding or reexamine using different conditions or ground rules; or these future studies could be aimed at finding more new ideas.

- end -

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AC 202-453-8400

Paula Cleggett-Haleim
Headquarters, Washington, D.C.
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For Release
July 17, 1989

RELEASE: 89-119

APOLLO-11 LUNAR EXPERIMENT STILL USEFUL AFTER 20 YEARS

An experiment placed on the lunar surface 20 years ago by the Apollo 11 astronauts continues to be used to study the Earth-moon system by NASA's Jet Propulsion Laboratory, Pasadena, Calif., and other scientific centers around the world.

Scientists, who analyzed the data from the Laser Ranging Retro-reflector Experiment, have observed, among other things, that the moon is moving away from the Earth, tectonic plates of the Earth are slowly drifting and the length of a day varies.

The Laser Ranging Retro-reflector was designed to reflect pulses of laser light fired from the Earth. The idea was to determine the round-trip travel time of a laser pulse from the Earth to the moon and back again, thereby calculating the distance between the two bodies to unprecedented accuracy. Unlike the other scientific experiments left on the moon, this reflector requires no power and is still functioning perfectly after 20 years.

The laser reflector consists of 100 fused silica half cubes, called corner cubes, mounted in an 18-inch square aluminum panel. Each corner cube is 1.5 inches in diameter. Corner cubes reflect a beam of light directly back toward the point of origin. It is this fact that makes them so useful in Earth surveying.

The McDonald Observatory, Ft. Davis, Texas; the Lure Observatory atop the extinct Haleakala volcano on the island of Maui, Hawaii; and a third observatory in southern France near Grasse, regularly send a laser beam through an optical telescope and try to hit one of the reflectors.

- more -

The reflectors are too small to be seen from Earth, so even when the beam is correctly aligned in the telescope, actually hitting a lunar reflector is quite challenging. At the moon's surface, the beam is roughly a mile wide and scientists liken the task of properly aiming the beam to using a rifle to hit a moving dime 2 miles away.

Once the laser beam hits a reflector, scientists at the observatories use sensitive filtering and amplification equipment to detect the return signal. The reflected light is too weak to be seen with the human eye, but under good conditions, one photon -- the fundamental particle of light -- will be received every few seconds.

Three more reflectors have since been left on the moon, including two by later Apollo missions and one by the unmanned Soviet Lunakhod 2 lander. Each of the reflectors rest on the lunar surface in such a way that its flat face points toward the Earth.

Continuing improvements in lasers and electronics over the years have led to measurements accurate to approximately 1 inch. Scientists know the average distance between the centers of the Earth and the moon is 239,000 miles, implying that the modern lunar ranges have relative accuracies of better than one part in 10 billion. This level of accuracy represents one of the most precise distance measurements ever made and is equivalent to determining the distance between Los Angeles and New York to one fiftieth of an inch.

During the last 20 years, scientists have used the orbit of the moon and the lunar ranging sites to study events on Earth. Lunar ranging has contributed to several scientific advances:

* Lunar ranging has helped determine the precise positions of the observatories that send the laser beams. Using these positions, scientists can tell that the tectonic plates of the Earth's crust are slowly drifting and the observatory on Maui is seen to be moving away from the one in Texas.

* The atmosphere, tides and the core of the Earth cause changes in the length of an Earth day -- the variations are about one thousandth of a second over the course of a year.

* The familiar ocean tides raised on the Earth by the moon have a direct influence on the moon's orbit. Laser ranging has shown that the moon is receding from the Earth at about 1.5 inches every year.

* Lunar ranging, together with laser ranging to artificial Earth satellites, has revealed a small but constant change in the shape of the Earth. The land masses are gradually changing after being compressed by the great weight of the glaciers in the last Ice Age.

* Predictions of Einstein's Theory of Relativity have been confirmed using laser ranging.

* Small-scale variations in the moon's rotation have been measured. They result from irregularities in the lunar gravity field, from changes in the moon's shape due to tides raised in the moon's solid body by the Earth and possibly from the effects of a fluid lunar core.

* The combined mass of the Earth and moon has been determined to one part in 100 million.

* Lunar ranging has yielded an enormous improvement in knowledge of the moon's orbit, enough to permit accurate analyses of solar eclipses as far back as 1400 B.C.

The usefulness of continued improvements in range determinations to further advance understanding of the Earth-moon system and the need for monitoring details of the Earth's rotation will keep the lunar reflectors in service for years to come.

Lunar ranging analysis at JPL is undertaken by Drs. Jean Dickey, James G. Williams and X X Newhall and is sponsored by the Geodynamics Branch of NASA's Office of Space Science and Applications. Additional analysis is accomplished at the Harvard/Smithsonian Center for Astrophysics and the Massachusetts Institute of Technology, both in Cambridge, Mass.; at the University of Texas, Austin; and in France and China.

-end-

EDITORS NOTE: A 4-minute, 38-second video clip supporting this press release is available from NASA by calling 202/453-8594.

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202-453-8400

Jim Cast
Headquarters, Washington, D.C.
(Phone: 202/453-8536)

Jim Elliott
Goddard Space Flight Center, Greenbelt, Md.
(Phone: 301/286-6256)

For Release:

4 p.m. EDT
July 18, 1989

RELEASE: 89-120

CONTRACTOR SELECTED FOR MEDIUM EXPENDABLE LAUNCH VEHICLE SERVICES

NASA's Goddard Space Flight Center, Greenbelt, Md., has selected McDonnell Douglas Space Systems Co., Huntington Beach, Calif., for negotiations leading to award of a firm, fixed-price contract for medium class, commercial, expendable launch vehicle services.

The contract, expected to be effective Oct. 1, 1989, will provide launch services for three firm missions -- the International Solar Terrestrial Program (ISTP) GEOTAIL, WIND and POLAR missions -- and 12 optional missions currently unidentified. The GEOTAIL, WIND and POLAR missions presently are manifested for July 1992, December 1992 and June 1993, respectively.

The contract will provide for institutional launch service capability for medium class payloads. The period of performance will be from the effective date of the contract through launch of all options exercised. Launch options may be exercised for a period of 5 years after the effective date of the contract.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202-453-8400

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Headquarters, Washington, D.C.
(Phone: 202/453-1548)

Ray Villard
Space Telescope Science Institute, Baltimore, Md.
(Phone: 301/338-4514)

For Release:
July 19, 1989
10:00 a.m. EDT

RELEASE: 89-121

SCIENCE OBSERVATIONS SELECTED FOR NASA/ESA HUBBLE SPACE TELESCOPE

The Space Telescope Science Institute, Baltimore, Md., has completed selection of the first science observation proposals from the astronomy community to be carried out using the NASA/European Space Agency (ESA) Hubble Space Telescope.

The Hubble Space Telescope (HST), scheduled for launch in March 1990, is the first major international optical telescope to be permanently stationed in low-Earth orbit. Capable of viewing the universe with a tenfold greater resolution than ground based observatories, the HST has a tremendous potential for fundamental scientific breakthroughs in astronomy. Observing opportunities on the powerful space facility are open to the worldwide astronomical community.

"It is exciting to see the many excellant proposals and to think of the scientific discoveries that will soon emerge when the Hubble Space Telescope uncovers the mysteries of fundamental scientific questions," says Neta Bahcall, Head of the institute's Science Programs Selection Office.

The selected observations will make use of HST's unique capabilities to study a wide variety of astronomical objects, from nearby planets to the horizon of the visible universe. The observations should help to dramatically improve current understanding of the size, structure and evolution of the universe.

Among the accepted proposals are plans to search for black holes in neighboring galaxies, to survey the dense cores of globular star clusters, to better see the most distant galaxies in the universe, to probe the mysterious core of the Milky Way galaxy and to search for neutron stars that may trigger bizarre gamma-ray bursts.

- more -

The 162 proposals were accepted following an intensive scientific peer review of 556 proposals submitted by astronomers from 30 countries. Approximately 20 percent of the proposals were from member nations of the European Space Agency, a joint partner with NASA on the HST project.

The HST is such a powerful, new resource for optical astronomy, that observing time was heavily oversubscribed. During the first 12-month observing cycle, 11,000 hours of observing time were requested, with only 1200 hours available. The average length of an accepted observation is 10 hours.

"Unfortunately, because of the high oversubscription rate, many excellent proposals could not be accommodated," says Bahcall. "We expect that the available observing time will be somewhat larger in the second cycle, due to a higher anticipated HST observing efficiency and a lower fraction of time committed to guaranteed time observers (GTO)."

When HST is launched, it will undergo a 7 month check-out and instrument calibration period. During that time some of the first science observations will be made by the GTOs. They are the astronomers on the six teams which developed HST instrumentation, as well those astronomers who contributed to the design of the 12-ton observatory.

General observer proposals will begin 7 months after launch and most will be completed within a 12-month period, though a few key projects will be extended over 3 years. Slightly more than half of HST's observing time for the first year of operation will be available for general observers. The remainder of the observing time will be used by the GTO's.

To utilize every moment of observing time and hence maximize efficiency, HST is "over-booked" with accepted general observer proposals by a ratio of 3:1. One hundred eight accepted proposals are high priority and represent 90 percent of HST observing time. The remaining 54 supplemental proposals essentially "fly standby." They will only be executed if appropriate scheduling opportunities arise.

Sixty-two scientists including 10 from ESA member nations participated in the proposal review and selection process. The scientists were divided into six peer-review panels which covered sub-disciplines in astronomy such as solar system, stellar astrophysics, stellar populations, interstellar medium, galaxies and clusters, quasars and active galactic nuclei.

Each proposal was judged primarily for scientific importance. Other selection criteria took into account such factors as the technical feasibility of the proposal and an observer's need for the unique capabilities of HST.

The ranked lists of proposals assembled by the various panels were then reviewed by a cross-discipline Time Allocation Committee (TAC). Space Telescope Science Institute Director Riccardo Giacconi made the final selection based upon a review of the TAC's recommended list of proposals.

The proposals now will go through a phase II process where the guest observers will specify the technical details of their observations. The proposals then will be checked for technical feasibility, such as availability of guide stars required to aim the telescope in space and other possible problems. At the conclusion of phase II this fall, a catalog of approved observations will be made available.

The Space Telescope Science Institute is operated for NASA under a contract with the Goddard Space Flight Center, Greenbelt, Md., by the Association of Universities for Research in Astronomy, Inc. The institute is located on the Johns Hopkins University campus in Baltimore, Md.

-end-

NOTE TO EDITORS: A listing of the 162 HST proposals is available from the NASA Headquarters newsroom.

NASA News

National Aeronautics and Space Administration

Washington, D.C. 20546
AC 202-453-8400

Mary L. Sandy
Headquarters, Washington, D.C.
(Phone: 202/453-2754)

For Release:

July 24, 1989
Embargoed until 9:30 a.m.

H. Keith Henry
Langley Research Center, Hampton, Va.
(Phone: 804/864-6120)

RELEASE: 89-122

NASA STUDIES HEAVY RAIN EFFECTS ON AIRCRAFT PERFORMANCE

Preliminary results from a series of high-speed ground tests indicate that heavy rain may reduce aircraft wing performance when it is most needed, during landing approach or take-off in the presence of a microburst storm, an important factor for pilots to consider while flying through severe storms, according to researchers at NASA's Langley Research Center, Hampton, Va.

Until recently, explains R. Earl Dunham, Jr., Langley Heavy Rain Project Manager, little attention has been directed to the influence of rain on aircraft wing performance since rain effects were thought to be insignificant.

A survey of commercial aircraft accidents and incidents related to severe storms prompted NASA to study the possibility of a heavy rain effect on aircraft safety and performance. Heavy rain is generally defined as a high-intensity, short-duration rainfall.

Modern wings on commercial aircraft, optimized for economy, rely on a smooth, uninterrupted flow of air across the wing surfaces for maximum performance. Tests suggest that very heavy rain disrupts the airflow, reducing wing lift and performance.

The heavy rain research is part of a broad NASA-Federal Aviation Administration airborne wind shear detection and avoidance program begun in 1986.

Understanding heavy rain is important to the study of wind shear. In cases where greater than usual wing lift is required, as in a low-altitude encounter with wind shear, heavy rain may reduce wing performance when it is most needed.

- more -

In fact, a series of small-scale wind tunnel tests in the mid-1980's suggested that there is a heavy rain effect at extremely high rain rates. Wing lift losses of greater than 20 percent were observed when simulated very heavy rain was sprayed on a test wing in the tunnel.

To test in more realistic conditions, the program was extended to the present high-speed, large scale ground tests. Results after the first 20 runs tend to verify the wind tunnel tests for the particular wing section being tested, namely that at extremely high rain rates there is a significant loss of wing lift, a loss that could be critical to safety of flight in high-lift conditions such as approach or takeoff.

During the next phase of the program, the project team plans to change the rain rate to determine at what point heavy rain begins to affect wing performance. The key question being addressed -- are heavy rain effects a potential concern even at light or moderate rain rates or is it something to consider only in the most intense downpours. The answer is important to help define the seriousness of the problem.

If heavy rain effects prove to be significant under realistic flight conditions, it follows, says Dunham, that piloting procedures need to be changed to take these effects into account. Present piloting procedures are based on what is known about flying through dry air. No corrections to performance have been developed previously to account for the effect of heavy rain on airfoil performance.

Questions about possible heavy rain effects were first asked by researchers looking at wind shear and related strong downdrafts called microbursts. Microbursts are small, intense downdrafts which, upon striking the ground, spread out into a circular vortex radiating in all directions. When microbursts are encountered at low levels on approach or takeoff, the pilot usually has little time to react correctly to maintain the desired flight path. Between 1964 and 1985, there were at least 26 accidents and 3 incidents involving 500 fatalities and more than 200 injuries where wind shear was the direct cause or a contributing factor.

In 1980, James Luers and Patrick Haines of the University of Dayton Research Institute, Dayton, Ohio, performed theoretical calculations based on their hypothesis that aircraft performance is reduced during heavy rain and wind shear periods. The work was funded under a grant from NASA's Goddard-Wallops Flight Facility, Wallops Island, Va. Following these calculations, small scale wind tunnel tests were conducted at Langley. These tests indicated a possible effect that required verification at more accurately simulated actual flight conditions with full-size wing sections.

As a result, ground tests using a tubular steel carriage are being conducted at Langley on a half-mile track originally constructed to test aircraft tires and landing gear. The 127,000-pound carriage is propelled down the track by a burst of high-pressure water. In 2-3 seconds, the carriage accelerates to 184 mph and the airfoil mounted on top the carriage "flies" through simulated heavy rain provided by 1,590 nozzles suspended from 6 trusses spanning the track. The airfoil represents a full-scale wing section, with working flaps, from a typical modern commercial transport.

NASA's current test program is expected to require about 60-80 carriage runs. They will continue this year until freezing weather makes using the water propulsion and spray systems impractical.

- end -

Photographs and a video clip are available to illustrate this release by calling 202/453-8375.

89-HC-92
89-HC-93

NASA News
National Aeronautics and
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Washington, D.C. 20546
AC 202-453-8400

For Release:

Debra J. Rahn
Headquarters, Washington, D.C.
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July 21, 1989

RELEASE: 89-123

U.S./USSR EARTH SCIENCES GROUP IDENTIFY AREAS OF COOPERATION

The U.S./USSR Joint Working Group on Earth Sciences held its second meeting in Washington D.C., July 17-21, 1989. The group agreed to cooperate in two sub-satellite experiments related to land-atmosphere interactions, outlined plans for a joint research program in volcanology and agreed to cooperate in studies of changes in the Earth's cryosphere in response to global climate warming.

The two sub-satellite experiments call for nine Soviet scientists to provide ground-based and airborne experiments and to participate in the U.S. first field experiment in the International Satellite Land Surface Climatology Project in Kansas during the summer of 1989.

Ten U.S. scientists will provide experiments and participate in a similar experiment near Kursk in the USSR in 1991. The experiments will include the exchange of Soviet and U.S. satellite data on these sites.

The joint research program in volcanology includes a prospective joint field verification campaign in Kamchatka, USSR, in 1990 and a subsequent campaign in comparable U.S. volcanic research sites. A measurement campaign using airborne, satellite and ground-based techniques could follow, as a later phase of joint research. Plans for the field verification campaign in Kamchatka are expected to be confirmed and refined at a working level meeting in the fall.

A cooperative project to study changes that are occuring in the Earth's cryosphere in response to global climate warming was initiated with the participation of the U.S. Geological Survey, NASA's Goddard Space Flight Center, Greenbelt, Md., and the Institute of Geography of the USSR Academy of Sciences. The two sides will prepare experimental maps, compiled from satellite remote sensing imagery, to document changes that have occurred and are occurring in the coastal regions of Antarctica.

- more -

Both sides noted with satisfaction the progress achieved in the preparation of the U.S. Total Ozone Mapping Spectrometer to be flown on the Soviet Meteor 3 spacecraft in the second half of 1991.

Both sides expressed support for continued interaction between the U.S. and USSR in oceanographic research programs related to understanding ocean processes of importance in global change.

Joint scientific meetings are planned to discuss biospheric dynamics and problems of desertification and forest stress. Additional information exchanged on trace gases and research in ocean remote sensing are expected to lead to joint activities at subsequent meetings.

Academician Kyrill Ya. Kondratiev of the Institute of Lake Studies, USSR Academy of Sciences, in Leningrad, is the Soviet Co-Chairman of the group. Dr. Shelby G. Tilford, Director of the NASA Earth Sciences and Applications Division, is the U.S. Co-Chairman.

The objective of the group is to conduct joint experiments and to acquire and exchange space-based and related ground-based data important to solving problems associated with global change.

The group was formed pursuant to the Agreement between the United States of America and the Union of Soviet Socialist Republics Concerning Cooperation in the Exploration and Use of Outer Space for Peaceful Purposes, signed in Moscow on April 15, 1987, as amended May 31, 1988.

- end -

NASA News
National Aeronautics and Space Administration
Washington, D.C. 20546
AC 202-453-8400

For Release:

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Carter Dove
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July 24, 1989

RELEASE: 89-124

NASA TO STUDY HOW VEGETATION INFLUENCES WEATHER, CLIMATE

NASA scientists, joined by others from the U.S., Soviet Union, Canada, England and France, will set up camp during mid-summer on a prairie grassland site in Central Kansas to learn how land surface vegetation regulates the rate of soil moisture return to the atmosphere, ultimately influencing local weather and regional climate.

In addition to land surface vegetation, scientists also expect to learn more about the effects on climate of other land surface properties, such as soil moisture and regional hydrologic characteristics.

The NASA-managed effort -- led by scientists from the Laboratory for Terrestrial Physics at Goddard Space Flight Center, Greenbelt, Md. -- is an element of the International Satellite Land Surface Climatology Project (ISLSCP) and is known as FIFE, the first ISLSCP field experiment.

FIFE '89, with data from five Earth remote-sensing satellites, six research aircraft and dozens of high-tech surface and airborne measurement devices, is being conducted on and over a 9-by-9 square mile area in the Konza Prairie Natural Area, just north of Interstate 70, near Manhattan, central Kansas.

A period of intensive, simultaneous observations will be conducted from the week of July 23 until Aug. 12.

- more -

According to Dr. Forrest Hall, the FIFE science coordinator with Goddard's Earth Resources Branch, data from the ground, aircraft and satellite-generated observations will be placed in a computer data base at Goddard for access by all FIFE investigators.

Additionally, results of the FIFE investigation will be made available, Hall said, to the scientific community through publication in journals and other established channels.

One of the many users of the results generated by the project will be Dr. Piers Sellers of the University of Maryland, at College Park, the FIFE staff scientist. Instrumental in the design of FIFE, Sellers will combine computer models of vegetation with global weather to improve the understanding of how vegetation interacts with the atmospheric circulation.

The data for the FIFE study will come from:

o Automatic meteorological stations: Dozens of these will report on temperature, humidity, wind speed, several components of radiation flux, soil temperature and precipitation at 15-minute intervals.

o Aircraft: Five U.S. and one Canadian Twin Otter research aircraft will be deployed to measure fluxes of water and energy to the atmosphere or to remotely sense visible, near-infrared, thermal-infrared and active and passive microwave energy reflected from the Earth's surface.

o Satellites: Data sets will be compiled from five U.S. Earth remote sensing satellites: Geostationary Operational Environmental Satellite; National Oceanic Atmospheric Administration-9 and -10; and LANDSAT-4 and -5. Data from the French SPOT satellite also will be used extensively.

Recent scientific studies have shown that when a dry period causes local soil moisture levels to drop below a critical level, surface vegetation could intensify the drought by limiting evapotranspiration, depriving the lower atmosphere of moisture needed for cloud formation.

- end -

NASA News

National Aeronautics and Space Administration

Washington, D.C. 20546
AC 202-453-8400

David W. Garrett
Headquarters, Washington, D.C.
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For Release:

July 25, 1989

RELEASE: 89-125

O'BRIEN RETURNS TO NASA AS ASSISTANT DEPUTY ADMINISTRATOR

NASA Administrator Richard H. Truly today announced that John E. O'Brien will return to NASA as Assistant Deputy Administrator, NASA Headquarters, effective July 30.

In this position, O'Brien will support the agency's efforts in formulating plans to implement future goals in space as outlined by President Bush in his July 20 speech. Also, he will perform special analyses for the Administrator and be involved in management problem solving.

O'Brien returns to NASA from the Washington law firm of Steptoe & Johnson where he specialized in defense and aerospace legal issues. He previously served as NASA General Counsel from August 1985 to July 1988 after serving as Deputy General Counsel since November 1981. He joined NASA in 1962 as staff attorney at NASA's Launch Operations Center, now the Kennedy Space Center. Prior to that position, he had served as staff attorney at the Navy General Counsels Office in Washington, D.C., from 1957 to 1962. In 1970, he was appointed Chief Counsel of the Kennedy Space Center and NASA Assistant General Counsel for Procurement Matters in 1973.

O'Brien received the NASA Exceptional Service Medal in 1976 and the NASA Distinguished Service Medal in 1988. He was awarded the Presidential Rank of Meritorious Executive in 1980 and the Presidential Rank of Distinguished Executive in 1988.

O'Brien received a BA degree from Niagara University and a Juris Doctorate degree from Georgetown University. During 1965-66, he was a Princeton Fellow in Public Affairs at the Woodrow Wilson School of Public and International Affairs, Princeton University. He is a member of the D.C. Bar, Virginia State Bar, the Federal Bar Association, the American Bar Association, the International Bar Association and the International Institute of Space Law.

-end-

National Aeronautics and
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Washington, D.C. 20546
AC 202-453-8400

For Release:

Jim Kukowski
Headquarters, Washington, D.C.
(Phone: 202/453-8425)

July 26, 1989

Terry Brooks
Jet Propulsion Laboratory, Pasadena, Calif.
(Phone: 818/354-6278)

N89-55

EDITORS NOTE: VOYAGER 2/NEPTUNE ENCOUNTER, NASA SELECT TV PLANS

NASA will employ two satellites to transmit television coverage of the Voyager 2 flyby of planet Neptune next month. The second satellite transponder will provide encounter television access to Alaska and Hawaii and a vastly improved television signal for the western United States.

The satellites will provide program transmissions August 21 through August 29 from NASA's Jet Propulsion Laboratory (JPL), Pasadena, Calif. Daily programming will begin at noon and continue through approximately 8:30 p.m., EDT. Coverage will be expanded on August 24 when Voyager is nearest to Neptune.

Recent Neptune images received from Voyager 2 indicate weather changes around the planet are extremely dynamic. Voyager 2 cameras now show large white clouds moving rapidly around and away from the recently discovered massive dark spot. In addition, a new moon has been discovered by JPL scientists. The moon measures about 120 to 400 miles in diameter.

The NASA television transmissions will be hosted by Dr. Albert Hibbs and other JPL scientists. Status reports will be provided hourly and will include interviews and presentations by mission scientists. Neptune encounter news briefings are scheduled daily at 1 p.m., EDT, and will include more formal scientific presentations.

A special 76-minute, pre-encounter television presentation will be transmitted over Satcom F2R, only, at noon EDT, August 7 and August 14. Dr. Edward Stone, Voyager Project Scientist, will provide a 46-minute summary of scientific findings made by Voyagers 1 and 2 at Jupiter, Saturn and Uranus. In addition, there will be a 30-minute video of the best images of Jupiter, Saturn, Uranus and moons of the planets taken by Voyager.

- more -

JPL has published a Voyager/Neptune Encounter NASA Television Public Access Program Development Guide, which is available to educational institutions, planetariums, science centers, cable television operators and television stations by contacting:

Terry Brooks, Code 180-200
JPL, 4800 Oak Grove Drive
Pasadena, CA 91109

Phone: 818/354-6278

VOYAGER 2 NEPTUNE ENCOUNTER TELEVISION SUMMARY
Aug. 21-29, 1989

SATELLITE VIDEO SOURCES:

GE Satcom F2R	Aurora 1
Transponder 13	Transponder 6
72 W. Long.	143 W. Long.
3960 MHz, vert. polar.	3820 MHz, hor. polar.

DATES/TIMES (August/EDT)

21, 22, 23	noon - 8:30 p.m.
24	noon - TBD *
25, 26, 27, 28	noon - 8:30 p.m.
29	noon - 3:30 p.m.

* Determined at encounter time, depending on data received.

DAILY PROGRAM EVENTS:

Mission status reports at noon and hourly, 3 to 8 p.m., EDT
Daily news briefing (90 minutes) at 1 p.m., EDT.

NOTES:

Live television images of the encounter will be shown between scheduled hourly updates and news conferences.

Hourly status reports will vary in length from 10 to 30 minutes.

For technical assistance, call JPL Audio/Visual Services, 818/354-6170.

- end -

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202-453-8400

For Release:

James W. McCulla
Headquarters, Washington, D.C.
(Phone: 202/453-8400)

July 27, 1989

RELEASE: 89-126

TRULY ASSIGNS JSC'S COHEN TO LEAD NASA PREPARATION FOR NEW CIVIL SPACE GOALS

Richard H. Truly, Administrator of NASA, today announced that he has asked Aaron Cohen, Director of the Johnson Space Center, to lead agency activities in response to the national goal of human exploration of the moon and the planet Mars announced by President Bush last week. Cohen will be temporarily assigned to NASA Headquarters in Washington for the next few months.

Speaking at the 20th anniversary of the Apollo 11 moon landing, the President asked Vice President Quayle to lead the National Space Council to determine what is needed for the next round of exploration to establish a scientific outpost on the moon and begin human exploration of Mars. Recommendations to the President will be influenced markedly by the NASA effort which Cohen will lead.

"From his engineering work in the early days of the Apollo program in the 1960s to today, when he leads the JSC team in support of the Shuttle and Space Station programs, Aaron has done outstanding work," Adm. Truly said. "No one in the agency is as well suited to prepare NASA to accept the challenges of this historic new project. Aaron will be calling on many other people across NASA to accomplish this comprehensive self-examination of the agency, and all of us look forward to this challenge. JSC will remain in good hands during this period under the leadership of Paul Weitz, the Deputy Director."

\- end -

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202-453-8400

For Release:

Mary Sandy
Headquarters, Washington, D.C.
(Phone: 202/453-2754)

July 28, 1989

Linda S. Ellis
Lewis Research Center, Cleveland
(Phone: 216/433-2900)

RELEASE: 89-127

MILESTONE REACHED IN SUPERCONDUCTIVITY

Scientists at NASA's Lewis Research Center, Cleveland, have established a new benchmark in the application of high-temperature superconductors to high-frequency electronic circuits. They have produced the first electronic circuit able to operate at 33 to 37 Gigahertz, a frequency range more than three times higher than attainable with previously developed circuits. A Gigahertz is 1 billion cycles per second.

Attaining these higher frequencies is important because advanced communications satellites will operate at 20-30 Gigahertz and above. These frequencies will allow satellites to process data at much faster rates, resulting in a three-fold increase in the number of communications linkups they can handle.

"We believe this is a breakthrough in the application of high-temperature superconductors, a first in this field at Lewis, which will lead to major improvements in space and terrestrial communication systems," according to Dr. Stuart Fordyce, Director for Aerospace Technology at NASA's Lewis Research Center.

The compactness and efficiency of the high-frequency circuit should reduce the size and mass of electronically aimed antennas at millimeter wavelengths, as well as increasing their pointing accuracy and tracking speed. Such antennas are desirable for future deep-space communications and remote sensing of the Earth's surface. The technology also may lead to dramatic improvements in terrestrial communications and data systems.

The Lewis Research Center team, led by Dr. Kul B. Bhasin, Space Electronics Division, Aerospace Technology Directorate, fabricated the circuit out of yttrium barium copper oxide, a material recently found to exhibit superconducting properties at higher temperatures than previously known materials.

- more -

A laser beam vapor deposition technique, developed by Lewis researcher Joseph D. Warner, was used to produce thin crystalline films of the superconducting material. The circuit then was constructed using integrated circuit fabrication techniques which the Lewis team adapted for use with the oxide superconductor. Meeting the technology challenges associated with fabricating high-temperature superconducting circuits at these high frequencies greatly improves the ability to make complex, reliable circuits such as those used in computer microprocessors.

Superconductivity is the absence of electrical resistance in a material that is sufficiently cold. For many years superconductivity could not be achieved above 23 degrees Kelvin (minus 419 degrees Fahrenheit). About 2 years ago, several laboratories produced materials that are superconducting above 90 degrees Kelvin. These "high temperature" superconductors opened new vistas because they can be cooled by liquid nitrogen rather than by liquid helium, which is more expensive and more difficult to handle.

Lewis Research Center, in partnership with Argonne National Laboratories, also is working on the development of large-scale superconducting systems for aerospace propulsion and power applications.

- end -

National Aeronautics and
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Mary Beth Murrill
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For Release:
August 3, 1989
11 a.m. EDT

RELEASE: 89-128

VOYAGER DISCOVERS 3 ADDITIONAL MOONS AROUND NEPTUNE

Images from NASA's Voyager 2 spacecraft have revealed three additional new moons in orbit around Neptune, Voyager imaging team scientists announced today.

The discovery brings to six the number of moons known to exist around the blue planet, including one, 1989 N1, discovered by Voyager 2 last month. The spacecraft, launched in 1977, has explored Jupiter, Saturn and Uranus and will come within 3,000 miles of Neptune at 12 midnight EDT, Aug. 24, 1989.

Finding so many moons when the spacecraft was more than 22 million miles away from Neptune may mean there are many more to be found in coming weeks, according to Voyager scientists.

The three newest Neptunian satellites, temporarily designated 1989 N2, 1989 N3 and 1989 N4, were tracked as candidate moons in images returned by the spacecraft over a 5-day period. When the objects were found to follow predicted orbits, Voyager imaging scientists yesterday were able to confirm them as moons of Neptune. Their temporary names designate the order in which they were discovered.

Like 1989 N1, the three new moons occupy nearly circular and equatorial orbits around the planet. All move in prograde orbits (in the same direction the planet rotates), making the large moon Triton, which occupies a retrograde orbit, even more of an oddity in the Neptune system.

- more -

The innermost of the new moons is 1989 N3, which orbits at a distance of about 32,300 miles from the center of the planet or about 17,000 miles from Neptune's cloud tops. It makes one complete orbit of Neptune every 8 hours, 10 minutes.

Next is 1989 N4, orbiting about 38,000 miles from the planet's center or about 23,300 miles from the cloud tops. It orbits the planet every 10 hours, 20 minutes.

The outermost is 1989 N2, orbiting at about 45,400 miles from Neptune's center or about 30,000 miles from the cloud tops. It completes an orbit every 13 hours, 30 minutes.

The three new moons exist in the region where partial Neptunian rings or "ring arcs" are thought to exist. If ring arcs exist, the new moons might play an important role in "shepherding" and maintaining them, Voyager scientists said. The search for moons and visible ring arcs will continue as Voyager 2 flies toward Neptune.

Several sequences of spacecraft activity include plans to point Voyager 2's cameras at any newly discovered ring arcs or moons.

The Voyager Mission is conducted by the Jet Propulsion Laboratory, Pasadena, Calif., for NASA's Office of Space Science and Applications.

- end -

National Aeronautics and
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August 9, 1989

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NEW SYSTEM USES ARTIFICIAL INTELLIGENCE TO MONITOR SPACECRAFT

Voyager 2's near encounter of Neptune in late August will provide researchers at NASA's Jet Propulsion Laboratory (JPL), Pasadena, Calif., with an opportunity to demonstrate a new expert system designed to monitor the condition of interplanetary spacecraft and ground operations.

The software demonstration, called the Spacecraft Health Automated Reasoning Prototype (SHARP), will be used by mission operators to better analyze radio signals from spacecraft as they are received through the Deep Space Network ground stations and sent to the mission control center at JPL.

The computer program combines conventional computer science methods with artificial intelligence techniques to automatically detect and analyze potential spacecraft and ground data systems problems.

Designed by the JPL's Computer Science and Applications Section, SHARP is written in the LISP programming language and uses an advanced artificial intelligence programming tool, STAR*TOOL. The program supplies a variety of advanced techniques needed for building artificial intelligence systems to meet NASA's goals for future space exploration.

The SHARP team, headed by computer scientist David Atkinson, earmarked Voyager 2's flyby of Neptune as a vigorous operational setting in which to evaluate the performance of the SHARP system. The telecommunications subsystem of the spacecraft was chosen for the prototype demonstration because glitches frequently occur in the telecommunications link.

- more -

"The technology is being extended in the next year to monitor other spacecraft subsystems, such as power, attitude and articulation control and scientific instrumentation," Atkinson said. "In addition, SHARP will be used to monitor several spacecraft missions simultaneously, including the Magellan mission to Venus and Galileo mission to Jupiter."

The SHARP system provides a broad range of analysis functions to aid in monitoring spacecraft and ground control systems. Information from a variety of data sources, for example, is centralized into a single workstation. SHARP automates processing and analysis of that data to enable automatic fault detection and diagnosis using artificial intelligence technology.

SHARP's expert system captures knowledge gained by Voyager experts over the last 12 years and mimics their decisions when problems arise. That produces quicker response times to mission anomalies. The system furnishes operators with dynamic graphics displays for viewing data in a variety of formats. The status of the spacecraft and ground stations can be determined at a glance through the use of color-coded displays, which change to reflect status updates or alarm conditions.

The automation efforts demonstrated in the SHARP system are designed to enhance the productivity of mission operations in the years ahead, reducing the workforce required to monitor spacecraft during critical planetary encounter phases.

The Voyager Project is managed by JPL. NASA's Offices of Aeronautics and Space Technology and Space Science and Applications are sponsoring the SHARP demonstration.

- end -

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August 8, 1989

RELEASE: 89-130

NASA PARTICIPATES IN FIRST "AIRSHOW CANADA"

A sleek, 80-foot-long mockup of the U.S. National Aero-Space Plane will be the centerpiece of NASA's pavilion at the first Airshow Canada, scheduled for August 9-13 in Abbotsford, British Columbia. The exhibit highlights America's past, present and future achievements in aeronautics and space technology, emphasizing the pivotal role played by NASA throughout this history.

The National Aero-Space Plane mockup will be surrounded by educational displays that explain the program's purpose and goals. Visitors will learn about the technology necessary to design and develop a vehicle capable of taking off and landing from airport runways, accelerating into Earth orbit and cruising at sustained hypersonic speeds (up to Mach 12).

In an adjacent exhibit area, a large "video wall" will present short programs on NASA's latest aeronautical research projects including the forward-swept-wing X-29 aircraft, the revolutionary XV-15 tilt-rotor and supercomputer-based aerodynamic studies.

In addition, the display will feature a "Tools For Testing" theme profiling NASA's wind tunnel research and the Numerical Aerodynamic Simulation (NAS) facility. On a separate monitor, visitors can view the colorful dancing swirls of a computational fluid dynamics simulation in motion.

Other panels of the display will illustrate several of NASA's Earth and space missions, including a detailed mural of Space Station Freedom in orbit. The rear of the exhibit will contain another large-screen monitor featuring an Apollo 11 commemorative program and other NASA videos.

- more -

In conjunction with its aerospace trade show and flying exhibitions, Airshow Canada is sponsoring a symposium entitled "Looking to 2020," which will examine the future air transport environment, the uses of space and the world of the airport. Louis J. Williams, NASA's Assistant Director for Aeronautics (General Aviation and Transport Aircraft) is scheduled to deliver a paper on technology challenges for future high-speed civil transports. Samuel Morello, Assistant Chief of the Flight Management Division at NASA's Langley Research Center, also is slated to describe the aircraft flight deck of the future.

Airshow Canada is an expansion of the Abbotsford International Airshow held annually for 27 years. Organizers expect more than 300,000 visitors to tour exhibits from 17 nations during the week-long exposition.

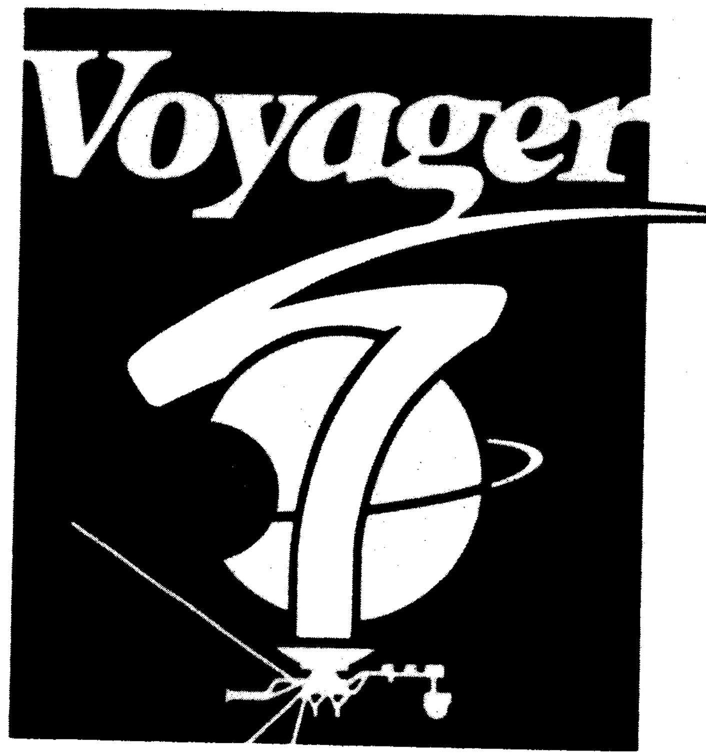
-end-

NOTE TO EDITORS:

NASA representatives will be at Airshow Canada to supply general information about the National Aero-Space Plane and other NASA aeronautics and space programs. Specific information can be requested from NASA Headquarters Public Affairs at 202/453-8900

NASA

VOYAGER 2 NEPTUNE ENCOUNTER PRESS KIT



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National Aeronautics and
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Washington, D.C.

RELEASE: 89-131

VOYAGER 2 ENCOUNTER OF NEPTUNE

Voyager 2, one of a pair of twin spacecraft launched by NASA in 1977, will complete its 12-year tour of the four giant outer planets of the solar system when it flies closely past Neptune at 12 midnight EDT, on Aug. 24, 1989.

Voyager's flyby will be the first time a spacecraft has visited Neptune, which orbits the sun at an average distance of 2.793 billion miles. Although Neptune is the fourth largest planet, it is invisible to the naked eye from Earth. Even the biggest and best telescopes on Earth have been able to discern only meager details about the planet.

Neptune is pale blue, about four times as big as Earth, and probably has a center consisting of a slurry-like mixture of ice and rock surrounded by gases of hydrogen, helium and methane. It holds in its orbit what appear to be fragmented rings and one of the largest and most interesting moons in the solar system, Triton. Striking latitudinal bands, a giant dark spot and smaller light spots have become apparent in Neptune's colorful atmosphere as Voyager has approached the planet. The early observations show that Neptune possesses a much more visibly, lively atmosphere than its supposed twin, Uranus, and that Neptune shares broad atmospheric characteristics with its larger planetary cousins Jupiter and Saturn.

Voyager 2 will pass within 3,000 miles of Neptune's cloud tops, which is closer than the flyby distance of any of Voyager 2's previous encounters. The spacecraft flew past Jupiter on July 9, 1979, Saturn on Aug. 25, 1981 and Uranus on Jan. 24, 1986.

The aging spacecraft's last close look at any body in the solar system will occur at 5:14 a.m. EDT, on Aug. 25, 5 hours after the closest approach to Neptune, when Voyager 2 will pass within 24,000 miles of the surface of the Neptunian moon Triton. The exact flyby distance to Triton won't be known until after it happens, because the moon's diameter cannot be measured precisely until the spacecraft gets there. Estimates based on observations from Earth put Triton's diameter at less than 2,240 miles.

Triton is expected to be one of the most interesting objects of the dozens Voyager 1 and 2 have studied in their long missions. The moon is thought to possess an atmosphere of methane and possibly nitrogen. In recent years, scientists have debated whether Triton might have frozen or liquid pools of nitrogen on its surface. In any case, studies from Earth suggest that whatever exists on Triton's surface should be visible through the atmosphere.

From Neptune, it will take 4 hours, 6 minutes for Voyager's radio transmissions -- traveling at the speed of light (186,000 miles per second) -- to reach Earth. The data will be received at NASA's Jet Propulsion Laboratory (JPL), Pasadena, Calif., where the Voyager mission was conceived, the spacecraft designed and constructed and the mission controlled.

The Neptune encounter takes place the week of the 12th anniversary of Voyager 2's Aug. 20, 1977 launch. An identical spacecraft, Voyager 1, was launched Sept. 5, 1977, and flew past Jupiter on March 5, 1979 and Saturn on Nov. 12, 1980.

The two Voyager spacecraft are the most intelligent machines to leave Earth's gravity, and they have accomplished the most productive mission of scientific exploration ever conducted by NASA. Together, the Voyagers have returned more new information about the outer planets and the interplanetary medium than had previously existed.

When launched, the spacecraft were designed to operate for about 5 years and encounter only two planets, Jupiter and Saturn. The destinations of Uranus and Neptune were authorized long after launch and Voyager 2 has gone the extra distance.

Two key spacecraft characteristics made the extra planetary encounters possible: reprogrammable onboard computers' receptive creative software engineering and three radioisotope thermoelectric generators -- devices that convert the heat from the radioactive decay of plutonium 238 into electricity to power the spacecraft components and instruments. The radioisotope thermoelectric generators allow the Voyager spacecraft to operate in regions of the solar system where solar panels cannot be used.

Voyager 2 already has begun returning a wealth of new information about Neptune. The imaging system alone -- just one of 11 scientific experiments on the spacecraft -- will return nearly 8,000 photographs of the remote, blue planet, its truncated system of rings, the Neptunian moons known to exist, as well as others that likely await discovery.

The Neptune encounter promises as many surprises as the Voyager spacecraft found at Jupiter, Saturn and Uranus. Remarkable phenomena and many new celestial bodies have been found wherever the Voyagers have traveled. Given past experience, Voyager scientists believe that, at the very least, the spacecraft will find more moons, a unique ring system and powerful storms in Neptune's blue atmosphere.

Among the major discoveries the Voyagers made at Jupiter were active volcanoes on the satellite Io, thin rings of dust encircling the planet and three new moons orbiting our solar system's largest planet.

At Saturn, Voyager 1 found that the large Saturnian moon Titan has an atmosphere composed primarily of nitrogen containing simple organic compounds that might have evolved into living organisms if Titan was not so cold. Several moons were discovered. Saturn's rings were found to be dynamic, with thousands of tiny wave-like features caused by the gravitational effects of small moons found in and around the rings. These radial spoke-like features may be electrically charged dust particles levitated above the ring plane.

At Uranus, Voyager 2 found a strange magnetic field with a corkscrew-shaped tail extending millions of miles into space. From the information Voyager returned about the magnetic field, Voyager scientists inferred that electrically conductive atmospheric layers must exist deep beneath the deceptively bland, visible atmosphere. Voyager's close-ups of the Uranian moon, Miranda, showed the small satellite to be dramatically fractured by geophysical forces. Miranda was found to have one of the most geologically diverse landscapes seen in the solar system.

More than 100,000 photos were taken during the Voyager 1 and 2 encounters of Jupiter and Saturn, and another 7,000 images were returned by Voyager 2 during the Uranus encounter.

Since the Uranus encounter, improvements have been made to the huge antennas at the NASA/JPL Deep Space Network (DSN) stations in Spain, Australia and California through which communications with the Voyagers are conducted. The three largest DSN antennas have been enlarged from 210 feet to 230 feet in diameter to maximize the amount of data that can be received from the spacecraft. The increased antenna aperture is extremely valuable, given that the strength of the signal received from Voyager amounts to only one ten-quadrillionth (1/10,000,000,000,000,000th) of a watt. For comparison, consider that a digital wristwatch operates at a power level 20 billion times greater. In addition to the enlarged antennas, the hearing of their super-sensitive receivers has been made even more acute with state-of-the-art supercooled, low-noise amplifiers.

Because of Neptune and Voyager's location in the sky, the Australian tracking site has the best radio "view" of the spacecraft and will receive most of the data returned during closest approach. The spacecraft will be almost directly above the Australian complex during the encounter. This is beneficial because Voyager's signal has a more direct, and thus less disruptive, path through the Earth's atmosphere there than it does when received at the stations in Spain or California. As during the Uranus encounter, the DSN antennas will be electronically linked to other large antennas that will simultaneously receive Voyager's faint signal, allowing more signal to be captured from the spacecraft. This technique, called arraying, greatly increases the data return from Voyager.

The Australian government's 210-foot Parkes Radio Telescope again will support the DSN when Voyager returns data during its closest approaches to Neptune and Triton.

The 200-mile distance between the DSN tracking station at Tidbinbilla and the Parkes Radio Telescope reduces the risk that data at both stations might be jeopardized due to simultaneous rain showers or thunderstorms.

The 210-foot Usuda Radio Observatory, owned by the Institute of Space and Astronautical Science of Japan, will join the Australian complex in collecting critical radio science observations during Voyager's closest approach to Neptune. In addition to the antenna array in Australia, the 27 90-foot antennas of the National Radio Astronomy Observatory's Very Large Array near Socorro, N.M., will be arrayed with the DSN station in California.

An unprecedented number of radio antennas on Earth are involved in the upcoming encounter. Altogether, 38 antennas on four continents will be used to receive data from Voyager during the Neptune flyby.

Mission controllers have taken full advantage of their ability to reprogram the 12-year-old spacecraft over the past several years and have taught it new methods for acquiring, processing and sending data. Routines executed by Voyager's onboard computers have been customized to allow the spacecraft to gather, compress and return as much information as it can while at Neptune. These new capabilities will help Voyager overcome problems caused by the dim lighting conditions at Neptune and the distance over which the spacecraft must communicate with Earth.

Voyager's flight path will be fine-tuned within days of the spacecraft's nearest encounter with Neptune. The point at which Voyager makes its closest approach to the planet was chosen to send the spacecraft on to its flyby of Triton. The trajectory will allow Voyager to avoid colliding with the vestigial rings that probably exist around the planet, while sending the spacecraft as close to the top of the planet's atmosphere as safety permits. Flying too close to Neptune could cause enough atmospheric drag on Voyager to damage the spacecraft or change its course. Last-minute changes in Voyager's instructions also will allow controllers to update the spacecraft on the precise locations of its targets and permit study of any new features or new moons that may become apparent as the spacecraft approaches Neptune.

Picture-taking at Neptune presents a multifaceted hurdle. Because of the faint sunlight at Neptune, which gets about a thousand times less sunlight than Earth, Voyager's camera shutters must be open longer to gather more light. Lengthy exposures in combination with the relative motion of the spacecraft and its target would normally result in badly smeared images. Innovative methods have been devised, however, to overcome these difficulties.

The encounter formally ends on Oct. 2, 1989, when Voyager 2 will be well past Neptune. From then on, Voyager 2 will join Voyager 1 in examinations of ultraviolet stars and in studies of fields, particles and waves in interplanetary space. It will begin its search for the heliopause -- the boundary between the solar wind and interstellar space. The heliopause has never been reached by any spacecraft, and the Voyagers may be the first to pass through this region. It is thought to exist somewhere between 50 and 150 astronomical units (5 billion to 14 billion miles) from the sun. Scientists expect that sometime in the next 10 years the two spacecraft will cross an area known as the termination shock. This is where the million mile-per-hour solar wind slows to about 250,000 miles-per-hour as the pressure of interstellar space impinges on the sun's influence. Ten to 20 years after reaching the termination shock, the Voyagers will cross the heliopause -- the end of the sun's influence.

Communications with the two spacecraft may continue until about 2020. At about that time, the electrical power provided to the spacecraft by their plutonium-based electrical generators will be below the level required to keep the Voyagers operating.

Eventually, the Voyagers will remotely pass by other stars. In about 40,000 years, Voyager 1 will fly within 1.6 light-years (9.3 trillion miles) of AC+79 3888, a star in the constellation of Camelopardalis. At about the same time, Voyager 2 will come within about 1.7 light-years of the star Ross 248. In 296,000 years, Voyager 2 will pass the star Sirius at a distance of about 4.3 light-years (25 trillion miles). The Voyagers are destined to continually wander through the Milky Way.

- end -

EDITOR'S NOTE: Encounter times used in this document denote the time the event occurs at the spacecraft; the data from the spacecraft will not be received on Earth until 4 hours, 6 minutes later.

THE VOYAGER MISSION

The Voyager mission was conceived and the spacecraft developed and constructed by the NASA Jet Propulsion Laboratory (JPL), Pasadena, Calif. The mission was born of a concept known as "The Grand Tour" to take advantage of a geometric arrangement of the outer planets in the late 1970s. This layout of Jupiter, Saturn, Uranus and Neptune, which occurs about every 176 years, would allow a properly pointed spacecraft to swing from one planet to the next without using large spacecraft propulsion systems. The gravity of each planet would bend the flight path and increase the velocity of the spacecraft enough to deliver it to its next destination.

Because they would be traveling too far from the sun to use solar panels, the Voyagers would use radioisotope thermoelectric generators. These devices, used on other deep space missions, convert the heat, produced from the natural radioactive decay of plutonium, into electricity to power the spacecraft instruments, computers and radio.

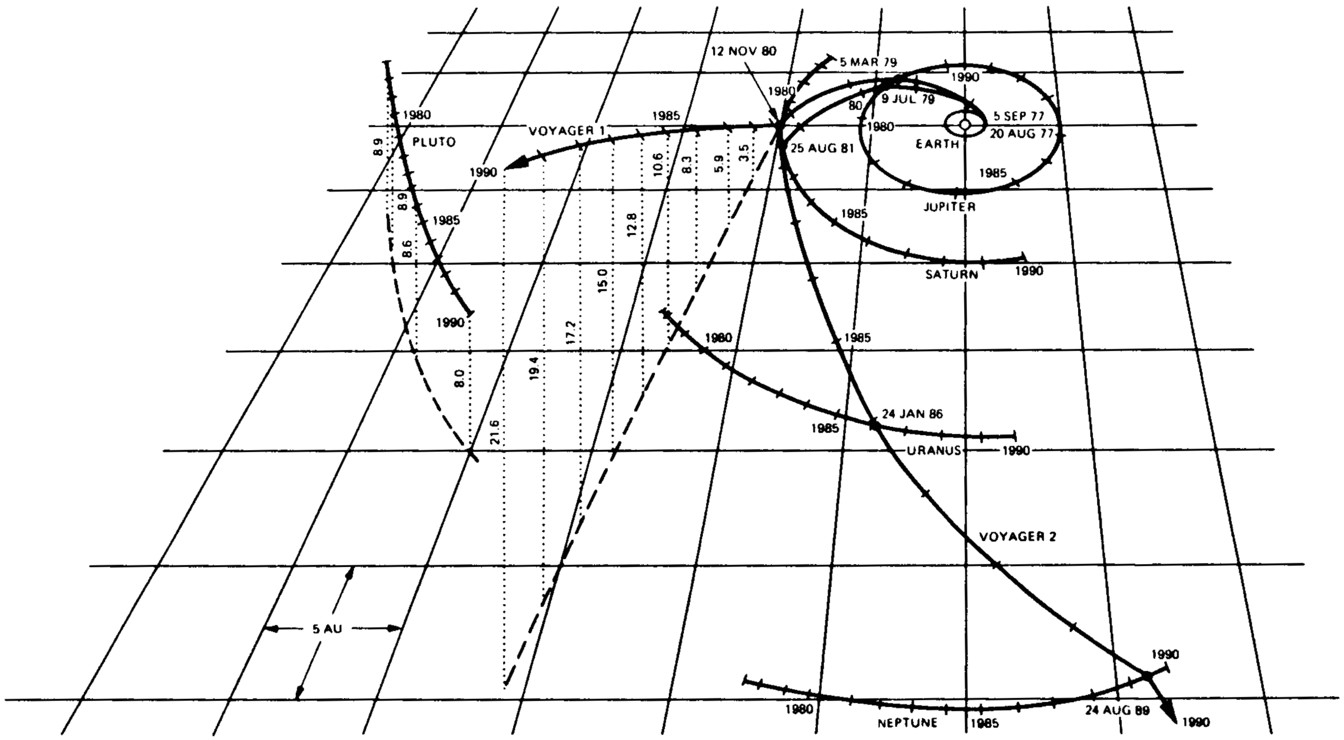
The Voyager mission was originally funded to conduct intensive flyby studies of only Jupiter and Saturn. From NASA's Kennedy Space Center, Fla., Voyager 2 was launched first, on Aug. 20, 1977. Voyager 1 was launched on a faster, shorter trajectory on Sept. 5, 1977. Both were launched atop Titan-Centaur launch vehicles.

Voyager 1 encountered Jupiter on March 5, 1979 and Saturn on Nov. 12, 1980. Voyager 2 encountered Jupiter on July 9, 1979 and Saturn on Aug. 25, 1981.

Mission planners might have sent one of the Voyagers directly from Saturn to Pluto, but geometric constraints would prevent the same spacecraft from making close flybys of Saturn's moon Titan, Uranus or Neptune. Titan was a critical target of the mission, so Voyager 1 would focus on that large moon and the Saturnian rings. In conducting its close studies of Saturn's rings and Titan, Voyager 1's flight path was thus bent inexorably northward out of the ecliptic plane -- the plane in which most of the planets orbit the sun. Voyager 2 meanwhile, was targeted to a point at Saturn that would automatically take it to Uranus and Neptune. Pluto had to be left for exploration by future generations.

After the successful completion of Voyager 2's Saturn encounter, NASA provided additional funding to continue operating the two spacecraft and authorized JPL to explore Uranus and Neptune with Voyager 2. The spacecraft encountered Uranus on Jan. 24, 1986, returning detailed photos and other data on the planet, its moons, rings and magnetic field.

Voyager 1 is still in operation and continues to press outward, conducting studies of interplanetary space. Its instruments may be the first to sense the boundary of this solar system and the beginning of interstellar space.



Trajectories of Voyagers 1 & 2

VOYAGER QUICK LOOK FACTS

CLOSEST APPROACHES

Location	Date	Time (at the spacecraft)	Distance
Nereid	8/24/89	8:12 p.m. EDT	2,890,000 mi
Ring-plane crossing (inbound)	8/24/89	11:03 p.m. EDT	
Neptune	8/24/89	12:00 midnight EDT	3,000 mi
Ring-plane crossing (outbound)	8/25/89	1:29 a.m. EDT	
Triton	8/25/89	5:14 a.m. EDT	23,600 mi

GENERAL FACTS

Voyager 1 Launch Date..........................September 5, 1977
Voyager 2 Launch Date..........................August 20, 1977

One-way light time, Voyager
at Neptune to Earth ....4 hours, 6 minutes

Distance of Voyager 2 from
Earth on August 24, 1989 ....2,748,802,418 mi

Velocity of Voyager 2 (on 8/24/89) ....Geocentric 90,381 mph
Heliocentric 43,236 mph

Total (arc length) distance Voyager 2 has
traveled since launch at closest approach ....4.4 billion mi.

Total number of images taken at Neptune 8,000

Cost of Voyager missions as of Neptune
Encounter (for both spacecraft not including
launch, tracking or data acquisition) ....$556 million

General directions of Voyagers after leaving solar system
.....Voyager 1 northward to the star AC+79 in Camelopardolis
.....Voyager 2 southward to the star Ross 248 in Andromeda

NEPTUNE

Neptune is the only planet to have been located through mathematical predictions rather than by systematic observations of the sky.

In the years following William Herschel's discovery of Uranus in 1781, astronomers noted that Uranus was not faithfully following its predicted path. Uranus seemed to accelerate in its orbit prior to 1822 and then slow down. Amateur astronomer T.J. Hussey in England suggested that Uranus's behavior might be attributed to the gravitational pull of an unknown planet.

Two mathematicians, each working without knowledge of the other, set out in search of the cause of Uranus's erratic behavior. In 1845, Englishman John Couch Adams took his calculations to Astronomer Royal Sir George Airy at the Greenwich Observatory. But Airy did nothing with the information. Then in 1846, Frenchman Jean Joseph Urbain Le Verrier, unable to interest astronomers in his own country, sent similar calculations to Johann Gottfried Galle at the Berlin Observatory. Galle began a search immediately. His assistant, Heinrich Louis d'Arrest, provided him with the latest star maps of the area in question. After about an hour's telescopic search on the first night, they found an unidentified disc in the sky. On the second night, after the object had moved, their discovery of an eighth planet could be claimed.

Currently, Neptune is the farthest planet from the sun. Pluto moved closer to the sun than Neptune in early 1979 and will move farther away in early 1999.

Neptune's equatorial diameter is about 30,700 miles making it only slightly smaller than Uranus, which has a diameter of 31,760 miles. But Neptune is denser than Uranus, which means that Neptune contains heavier material.

Neptune is believed to be composed primarily of hydrogen and helium. Atmospheric methane, which absorbs red light, gives Neptune its bluish hue. Clouds of methane are expected to condense at a pressure level of about 2 bars (twice the atmospheric pressure at sea level on Earth), at a temperature level of about -307 degrees Fahrenheit. Other cloud layers, including water ice clouds, probably exist deeper in the atmosphere.

At a distance of nearly 3 billion miles from the sun, Neptune receives about 1,000 times less sunlight than does Earth, and about two-and-a-half-times less than Uranus. But strangely, Neptune's overall temperature is about the same as that of Uranus's. Scientists believe that to account for this discrepancy, Neptune must have some internal heat of its own, as do Jupiter and Saturn.

Neptune's rotation rate is between 17 and 18 hours. The planet's rotational axis is tilted about 29 degrees to the plane of its orbit around the sun. (For comparison, the Earth's axis tilts 23.5 degrees.) Neptune's south pole is experiencing summer and "midnight sun" while its north pole is cloaked in darkness. Each season on Neptune lasts more than 40 years.

Scientists expect Neptune to have a magnetic field as do Mercury, Earth, Jupiter, Saturn and Uranus. It should be detected about 1 day before the spacecraft's closest approach to the planet.

Neptune's Rings

In recent years, astronomers have used a classic technique to search for rings around Neptune. On the rare occasions when Neptune moves in front of a bright star, observers on Earth look for flickers in the starlight. Rings may be deduced if the star's light dims or blinks on and off at regular intervals on both sides of the planet. In Neptune's case, the data has hinted of some ring material, but nothing has been observed to indicate that complete rings encircle the planet. The results of these searches lead scientists to believe that Neptune must be orbited by partial rings, or ring arcs, that are most likely composed of dust or pebble-sized material. There may be three narrow 5- to 12-mile nearly circular sets of arcs in or near Neptune's equatorial plane at distances that range from 11,000 to 26,000 miles from the planet's cloud tops.

Voyager 2's flight path carries the spacecraft close to the outermost set of possible ring arcs. As at Uranus, there is likely to be diffuse material that could fill much of the space within the ring arc region. Although such a diffuse sheet of material is not expected outside the ring arc area, the flight path can be adjusted as late as 10 days before the closest approach to Neptune in the event more distant ring arcs are discovered.

Several observations will be retargeted when individual ring arcs are located in images taken as the spacecraft approaches the planet. Pointing instructions for Voyager may be uplinked only a day or two before the spacecraft's closest approach to the planet.

As Voyager passes behind the rings, changes in Voyager's radio signal will be analyzed to determine the sizes of the particles in the rings as well as the structure of the rings or ring arcs.

Neptune's Moons

Neptune had two known satellites -- Triton and Nereid -- before Voyager began its approach. Voyager 2 found a third, designated 1989 N1, in early July. The new moon travels in a nearly circular, equatorial orbit, while neither Triton nor Nereid travels in the plane of the planet's equator. The plane of Triton's retrograde orbit (a direction opposite the planet's rotation) is at an angle inclined at about 20 degrees to Neptune's equator, while the plane of Nereid's prograde orbit (a direction with the planet's rotation) is at an inclined angle of 30 degrees.

In early August, Voyager 2 found three additional moons orbiting Neptune, bringing the total known moons to six. The three newest Neptunian moons, temporarily designated 1989 N2, 1989 N3 and 1989 N4, occupy nearly circular and equatorial orbits around the blue planet. All move in prograde orbits, making the large moon Triton, which occupies a retrograde orbit, even more of an oddity. All three new moons exist in the region where partial Neptunian rings or "ring arcs" are thought to exist. If the arcs exist, the new moons might play an important role in "sheperding" and maintaining them.

Triton is roughly the size of Earth's moon. Based on early observations by Voyager 2, Triton appears to be fewer than 2,500 miles in diameter. Earth's moon is 2,159 miles in diameter.

Until recent Voyager data suggested otherwise, scientists believed that because of Triton's peculiar retrograde orbit and the exaggerated tilt of its orbital plane, Triton must have been a planetesimal wandering the solar system alone when it was captured by Neptune. Since Voyager's discovery of 1989 N1, however, scientists are more uncertain about Triton's origin. If Triton were a relative newcomer to the Neptune system, it would have passed near enough to the low orbit of any preexisting moon such as 1989 N1 to collide with it or sweep it up through gravitational attraction. The existence of 1989 N1 in the orbit it occupies suggests that Triton may not be a captured object, but instead a native to Neptune.

Triton was discovered by William Lassell of England in 1846, less than a month after the discovery of Neptune.

Orbiting at an average distance of 220,300 miles from Neptune, Triton is nearly as far from its parent planet as the moon is from Earth. Triton is the only large moon in the solar system with a retrograde orbit. The moon completes one rotation on its axis every 5.88 days. That is the same amount of time it takes Triton to circle Neptune, so the satellite always shows the same face to Neptune, just as Earth's moon shows Earth.

Current evidence suggests that methane exists as frost or ice on the satellite's surface, giving rise to methane in the atmosphere. Triton is cold enough for nitrogen to exist as a solid on its surface and possibly as a liquid as well (liquid nitrogen's melting/freezing point is -346 degrees Fahrenheit.) Thus, Triton may harbor shallow puddles or iced pools of liquid nitrogen containing small amounts of methane and have nitrogen in its atmosphere at a pressure equivalent to about a tenth of Earth's atmosphere. Voyager should be able to see Triton's surface through the atmosphere.

Triton's reddish color is believed to be due to photochemistry -- the action of sunlight on hydrocarbons in the atmosphere -- like that which occurs in the much denser atmosphere of Saturn's moon Titan.

Voyager's instruments will probe Triton's surface in search of a rich, hydrocarbon sludge of organic molecules that might exist there.

Triton's highly inclined orbit may contribute to dramatic seasonal variations. Each pole spends 82 years facing the sun, while the other pole is in darkness. At the sunlit pole, ices of nitrogen, methane and argon may vaporize, adding to Triton's atmosphere. Meanwhile, vaporous substances at the dark pole would condense into an ice cap. This alternating shrinkage and growth of polar caps could mean that Triton's atmosphere varies dramatically, growing thicker and thinner with its 41-year-long seasons as it orbits the sun with Neptune every 165 years.

Nereid is between 190 to 680 miles in diameter and travels around Neptune in a highly elliptical orbit ranging from 862,000 to 5,987,000 miles. Nereid was discovered in 1949 by Gerard Kuiper of the United States.

Voyager 2's closest flyby distance to this little moon will be about 2,890,000 miles. Even at that range, Voyager may discern bright and dark areas on Nereid's surface.

The innermost of the new moons is 1989 N3, which orbits at a distance of 32,300 miles from the center of the planet or about 17,000 miles from Neptune's cloud tops. The moon 1989 N4 orbits about 38,000 miles from the planet's center or about 23,300 miles from the cloud tops. Next is 1989 N2, orbiting at about 45,400 miles from Neptune's center or about 30,000 miles from the cloud tops. The moon 1989 N1, which could range in diameter from 126 to 400 miles, orbits about 57,500 miles from Neptune's cloud tops. Voyager 2 will continue to study the new moons, and search for others, throughout the encounter.

The Radiation Environment at Neptune

The radiation environment near the planet is not expected to be as intense as that observed at Jupiter, where the radiation was fatal to Voyager 1's photopolarimeter instrument and temporarily desensitized the spacecraft's ultraviolet spectrometer. In addition, Voyager 1 sustained enough temporary radiation damage to confuse the spacecraft's internal clock, throwing off the synchronization between two of the computers onboard the spacecraft by 8 seconds. This timing problem resulted in, among other things, some smeared or blurred images of Jupiter and its moons.

Although the Voyager team believes such risks are minimal at Neptune, computer command sequences for the Neptune flyby have been carefully written to minimize adverse radiation effects on the observations.

SCIENCE OBJECTIVES

Voyager 2's complement of 11 investigations will be dedicated to more than two dozen major scientific objectives during the Neptune encounter.

The spacecraft is equipped to observe a broad range of planetary phenomena. At Neptune, it will find a banded, storm-ridden atmosphere, a ring system unlike any other in the solar system, a large and peculiar moon with an atmosphere of its own and probably several small icy or rocky moons that cannot be seen from Earth.

Ten instruments are mounted on various locations throughout the spacecraft and the radio through which Voyager communicates with Earth doubles as a scientific instrument that probes planetary and satellite atmospheres.

The instruments can be divided into two general classes: those that require pointing (remote sensors) and those that do not (in situ sensors).

There are five pointable instruments: the imaging science subsystem (consisting of wide-angle and narrow-angle television cameras), infrared interferometer spectrometer and radiometer, photopolarimeter, radio science subsystem and ultraviolet spectrometer. All but the radio ride on the spacecraft's steerable scan platform.

The other six instruments measure energetic particles, radio emissions and magnetic fields in space and near planets. They are the magnetic fields experiment (consisting of four magnetometers), plasma subsystem, low-energy charged-particle detector, cosmic-ray subsystem, plasma-wave subsystem and the planetary radio astronomy experiment.

Voyager 2's observations with these instruments can be divided into four groups at Neptune: atmosphere, rings, satellites and magnetosphere.

Atmosphere

Light emitted and reflected from Neptune's atmosphere will be measured by the photopolarimeter, the imaging and the infrared instruments to determine the atmospheric chemistry and composition.

As the spacecraft passes behind Neptune, the spacecraft's radio signals will pass through the upper layers of the atmosphere. As the signals are received on Earth, scientists will analyze how the received transmissions were affected as they passed through Neptune's atmosphere. This will determine such characteristics as the amount of atmospheric methane and helium. This 50-minute experiment also will determine the vertical structure of Neptune's ionosphere and study turbulence in the atmosphere and ionosphere.

Ultraviolet emissions from Neptune may form a corona above the atmosphere. Auroras may be seen in ultraviolet light on the dark northern face of Neptune near the north pole. As the spacecraft passes behind Neptune, the ultraviolet spectrometer will study the way sunlight is changed by the atmosphere. From this, scientists may derive the composition and thermal structure of the atmosphere.

While the ultraviolet spectrometer examines the upper atmosphere, the infrared and radio science experiments will provide information on the composition, pressures and temperatures deeper in the atmosphere.

Voyager scientists hope to observe and define the global circulation and meteorology of the upper, visible clouds of Neptune, as well as the horizontal and vertical distribution of clouds and hazes.

Various instruments, notably the infrared spectrometer, will be used to determine the heat balance at Neptune -- the ratio of internal energy emitted to solar energy absorbed. It is known that like Jupiter and Saturn, but unlike Uranus, Neptune emits more heat than it receives from the sun. Measures of the excess energy emitted will have important implications for theories on Neptune's formation and weather mechanisms. Imaging will help characterize wind speeds at different latitudes.

Voyager 2 will pass behind Triton, where both the sun and Earth will be hidden from view for about 3 minutes. The ultraviolet spectrometer will be able to view the atmosphere as the sun shines through it, and the spacecraft's radio beams will probe the atmosphere to determine temperature and pressure levels.

The masses of Triton and Neptune will be determined with Voyager's radio. As the spacecraft accelerates through the Neptunian system, the frequency changes in its radio signal -- the Doppler shift -- will be precisely measured to study the magnitude of the planet's and Triton's gravity. From this information, scientists can determine each body's mass.

Magnetic Field

The interplanetary medium through which Voyager flies is dominated by the solar wind -- charged particles blowing out from the sun. As the solar wind nears a planet, it is deflected by and flows around the planet's magnetic field.

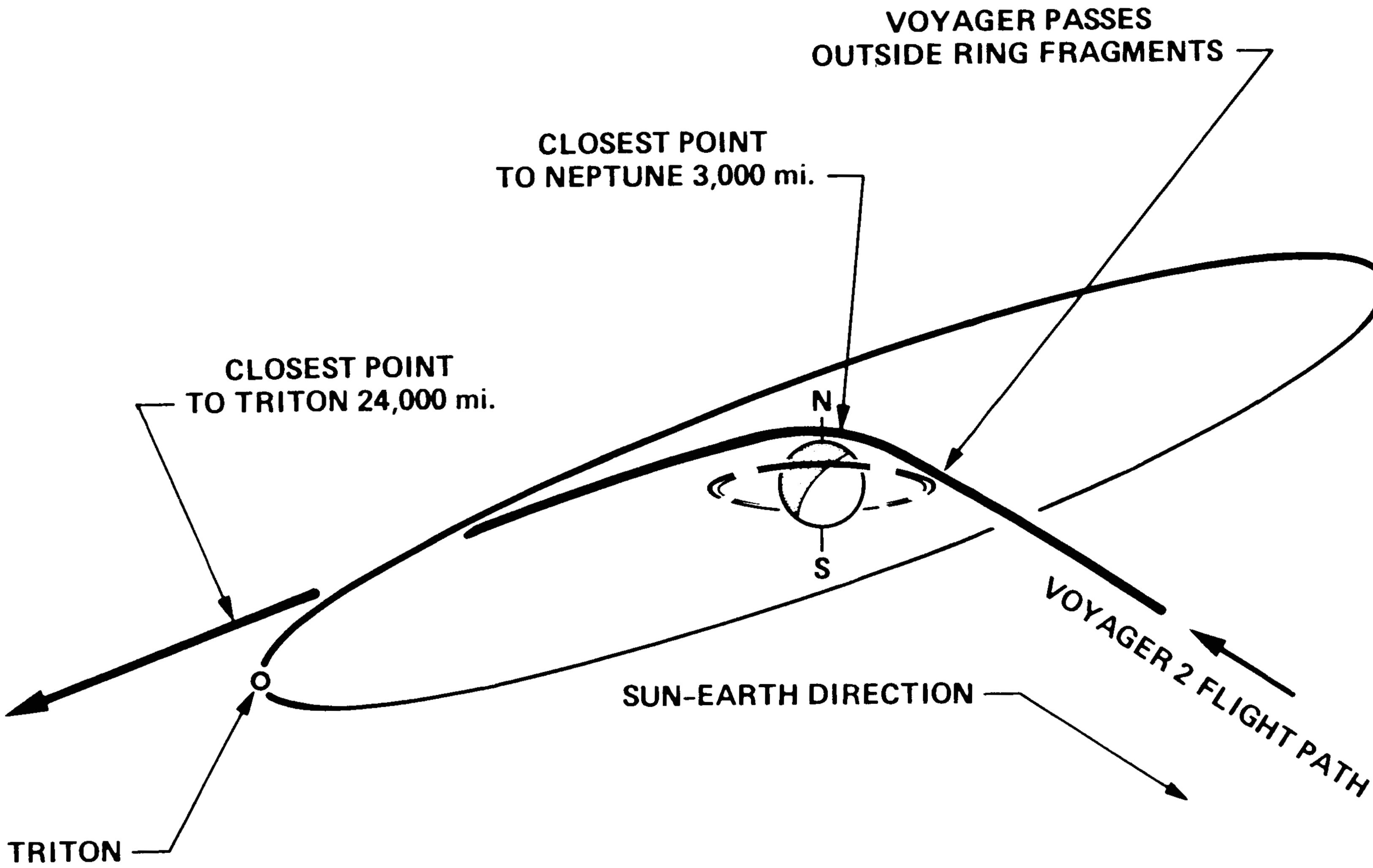
The magnetic fields of Earth, Jupiter, Saturn and Uranus are all shaped like windsocks, with the bulbous end facing the sun and a long tail sweeping behind the planet away from the sun. Where the solar wind meets the planet's magnetic field, there is a shock wave whose edge ebbs and flows according to the solar wind's varying strength.

Fields and particles instruments on Voyager 2 are continuously sampling the interplanetary medium, searching for signs of Neptune's magnetosphere. Voyager may fly through an auroral region over Neptune's north pole. About 1 hour before closest approach, the spacecraft will rotate to measure charged particles that probably spiral into Neptune's atmosphere in this region. On the dark side of Neptune, the ultraviolet instrument will look for auroral activity. About 2 hours after closest approach, the spacecraft will roll again to study plasmas that rotate with the planet.

Fields and particles investigations also will search for evidence of a torus from Triton -- a vaporous cloud composed of material carried off from the satellite's atmosphere that could surround Neptune. The instruments will look for "shadows" in the Neptune radiation environment -- gaps that would indicate the presence of unseen moons or ring arcs absorbing some of the trapped high-energy particles flowing along magnetic field lines.

Sometime before closest approach, Voyager 2's planetary radio astronomy antennas will pick up radio emissions generated in the planet's magnetosphere. These emissions are generated around other planets by energetic particles as they spiral along magnetic field lines into the atmosphere. As at Jupiter, Saturn and Uranus, such an emission from Neptune will give an accurate measurement of the planet's length of day.

The plasma wave instrument will search for signals produced in and around the magnetic field by plasmas, which are concentrations of charged particles. It also will detect lightning in the atmosphere and the presence of tiny ring particles that might strike the spacecraft as it moves through the Neptune system.



VOYAGER 2 FLYBY OF NEPTUNE
AUGUST 25, 1989

Rings

The partial rings or "ring arcs" of Neptune are probably made of dark material like the rings of Uranus. Searches for ring arcs will be conducted throughout the spacecraft's approach and during several retargetable observations planned for the near encounter-period. When in the shadow of Neptune, Voyager may see a broad sheet of ring particles backlit by the sun.

Voyager's instruments will be used to determine the size, distribution and reflective properties of ring particles. Toward this end, Voyager will conduct stellar occultation studies, measuring the amount of starlight from the star Sigma Sagitarii passing through the ring plane area. In addition, radio occultation studies will measure changes in a radio signal sent through the ring plane to Earth.

The photopolarimeter and radio experiment may pinpoint the locations of at least some of the ring arcs while helping to define their structures. Voyager will search for tiny satellites that could be affecting the organization of the distorted and broken ring system.

Moons

Triton's atmosphere will be measured by the photo-polarimeter, ultraviolet and infrared instruments, TV cameras and radio.

The ultraviolet instrument and photopolarimeter will gather information on the extent and structure of the moon's atmosphere as Triton eclipses the star Beta Canis Majoris from the spacecraft's point-of-view.

Infrared mapping of the moon's dark and sunlit sides will reveal temperatures and some surface properties. Variations in the surface temperature may indicate the existence of frozen or liquid nitrogen on the ground.

Radio science investigations will reveal the density of Triton's atmosphere and help determine its composition. Methane is known to exist in Triton's atmosphere and there is a suggestion that some nitrogen is present. A dense atmosphere is expected if it is mostly nitrogen-based; a less dense atmosphere if it is mostly methane (carbon-based). In either case, hydrocarbons, at least in the form of methane, are known to exist there, so Triton is certain to be home to more complex chemistry than exists on most other moons in the solar system.

A mosaic of high-resolution images of Triton will be used to map the surface and study geological processes, and photos of the atmosphere will provide clues to its composition.

Measurements of Triton's mass will be combined with the radius determined by radio occultation and imaging to estimate Triton's density. The density estimate will indicate how much rock and ice comprise the overall composition of the moon.

Science Plans Beyond Neptune

The Voyager Interstellar Mission will start after the completion of the Neptune encounter on Oct. 2, 1989. During this phase of the mission, Voyager 1 and Voyager 2 will be tracked as they move out of the sun's influence. But the beginning of the interstellar leg of Voyager 2's trek will mean the end of the working lives of some of the instruments on the spacecraft that will no longer be needed.

By about mid-1990, the cameras, infrared instrument and photopolarimeter will be turned off. The electrical energy savings from their shutdown will contribute to the operational lives of the other instruments -- planetary radio astronomy, plasma wave, low-energy charged-particle, plasma, cosmic ray and magnetic field -- that will measure the fields and particles these instruments observe during Voyager's passage into interstellar space. The ultraviolet spectrometer will be devoted to observations of ultraviolet stars. No regular radio science experiments are planned.

THE SCIENCE INSTRUMENTS

Imaging Science Subsystem

The imaging science subsystem consists of two television (vidicon) cameras mounted on the scan platform. The cameras photograph visible characteristics of the Neptunian system and are used to conduct searches for new satellites and ring material.

The wide-angle camera has a focal length of 200mm and is sensitive in the range of 4,000 to 6,200 angstroms. The narrow-angle camera has a focal length of 1,500mm and can image in the range from 3,200 to 6,200 angstroms. The imaging science subsystem weighs 84.2 pounds and uses 41.9 watts of power.

Each camera is equipped with a filter wheel whose individual filters have a wide variety of uses. These filters permit specific types or wavelengths of light to pass through and block all other types from reaching the camera detectors.

The wide-angle camera carries one clear filter; one filter each in blue, green and orange wavelengths; a sodium-D filter, and two filters for study of the distribution of atmospheric methane. The narrow-angle camera carries two clear filters, two green filters and one filter each of violet, blue, orange and ultraviolet.

The design of the Voyager imaging system was based on those of previous Mariner spacecraft with advances and changes dictated by the specific requirements of the Jupiter and Saturn encounters. Since the Saturn encounter, the cameras have been operating beyond the environment and lifetime for which they were designed, but no serious problems have occurred.

The very low light levels, relative velocities between spacecraft and target and the resulting long exposures required at Neptune necessitate the image-motion compensation techniques used during the Uranus encounter, in addition to new ones developed in the last 3 years.

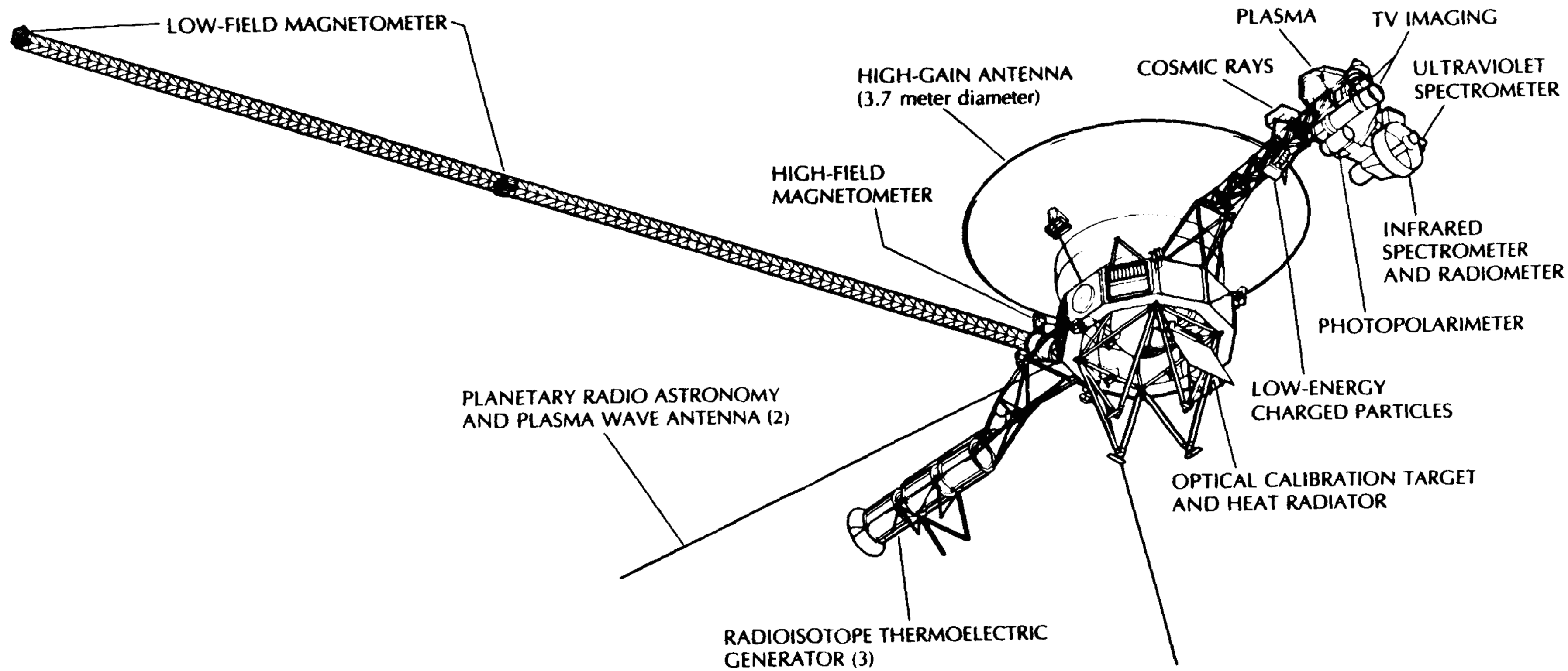
Three techniques will be used to compensate for the motion of the spacecraft and its targets during an exposure:

o "Classical image-motion compensation" was used extensively during the Uranus encounter and involves rotating the entire spacecraft to track the target during an exposure. This method necessarily moves the spacecraft out of contact with Earth, so images acquired this way must be tape-recorded on the spacecraft for later transmission.

o "Nodding image-motion compensation" is similar in effect to the "classical" technique, but rotates the spacecraft only to a point within the boundary where it would lose contact with Earth. Images acquired this way may be transmitted as they are taken. The spacecraft then rolls back, or "nods," to its original position, never losing communication with Earth.

o The third technique is called "maneuverless image-motion compensation" and uses only the movable scan platform, on which the cameras are mounted, to track the target while the spacecraft's attitude remains static. Communications with Earth are maintained using this technique.

As it flies through space, Voyager wobbles slightly in response to various activities on the spacecraft itself. Even the onboard tape recorder imparts motion to the spacecraft when the recorder stops, starts or changes direction at the end of the tape. To reduce this wobbling during flight, the spacecraft is steadied by automatic 10-millisecond jets of hydrazine propellant from its attitude control thrusters. The spacecraft motion, resulting from the 10-millisecond firings, would badly blur images during picture-taking, so flight engineers have shortened the jet firings to just 4 milliseconds during the encounter. The shorter jet firings will keep the spacecraft wobble under control while significantly reducing the image smearing that would otherwise occur.

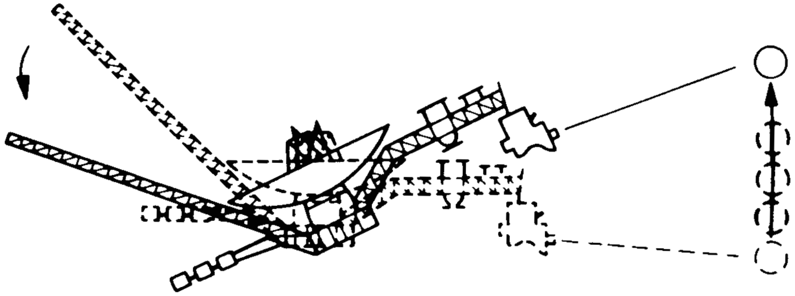


VOYAGER SPACECRAFT

Voyager

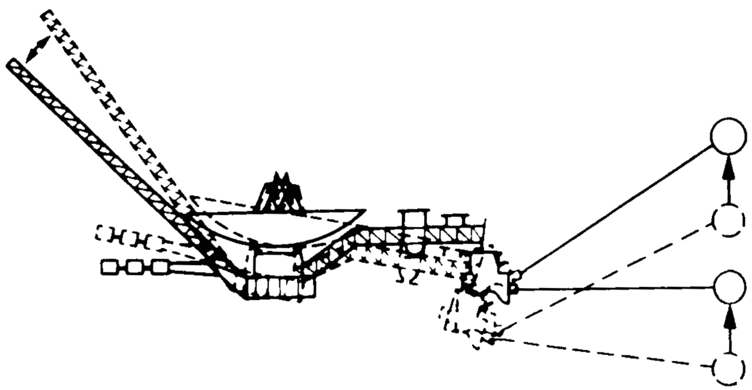
NEPTUNE NEAR ENCOUNTER HIGHLIGHTS

IMAGE MOTION COMPENSATION



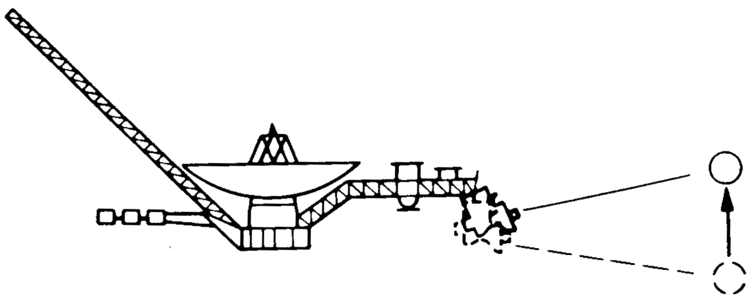
CLASSICAL IMC

ENTIRE SPACECRAFT TURNS TO TRACK TARGET - BREAKS COMMUNICATIONS LINK WITH EARTH



NODDING (NIMC)

SPACECRAFT "NODS" TO TRACK TARGET - STAYS ON EARTHLINE - CAMERAS REPOINTED BETWEEN IMAGES



MANEUVERLESS (MIMC)

MOVE SCAN PLATFORM ONLY - ELEVATION ONLY

Onboard spacecraft data compression and encoding techniques like those used at Uranus, in combination with the upgraded receiving capability of the DSN, have ensured that Voyager 2 will be transmitting high-quality data at a rate of 21.6 kilobits-per-second -- the same data rate used from Uranus -- despite being 1 billion miles farther from the Earth.

Despite Voyager's increased distance from Earth, it will send images back at the same rate at which images were transmitted from Uranus. Improvements in telecommunications capabilities on the ground will allow receipt of a maximum of about 12 to 17 images-per-hour and an average of about 200 a day. But this rate of return can be accomplished only through special techniques of data compression and encoding in which the 5 million bits-per-picture will be compressed to 2 million bits and fed into the telemetry stream at a lower rate than was used at Jupiter or Saturn.

Dr. Bradford A. Smith of the University of Arizona, Tuscon, is the imaging team leader.

Infrared Interferometer Spectrometer and Radiometer

The infrared interferometer spectrometer and radiometer is a telescope-based system that measures the spectrum of thermal energy radiated by Neptune and Triton at infrared wavelengths from 2.5 to 50 microns and the reflected light at wavelengths from 0.3 to 2 microns. The instrument weights 40.6 pounds and uses 14 watts of power.

Dr. Barney Conrath of NASA's Goddard Space Flight Center, Greenbelt, Md., is principal investigator.

Photopolarimeter Subsystem

The photopolarimeter subsystem (PPS) consists of a telescope fitted with filters and polarization analyzers. It measures the way its targets reflect light; it determines their properties as the reflected light is polarized by chemicals and aerosols in the case of Neptune's and Triton's atmospheres or by small particles in the ring arcs and on satellite surfaces.

The PPS will conduct studies of Neptune and Triton's atmospheres and the ring arcs. The instrument will measure changes in the starlight from Sigma Sagitarii and Beta Canis Majoris when Neptune, Triton and the ring plane pass in front of the stars from the spacecraft's point of view. The instrument weighs 9.72 pounds and uses 2.4 watts average power.

Dr. Arthur L. Lane of NASA's Jet Propulsion Laboratory, Pasadena, Calif., is principal investigator.

Radio Science Subsystem

Voyager's two-way radio communications link with Earth also is used to conduct scientific investigations. Precise measurements of the phase and amplitude of the radio signal can be analyzed to detect minute variations caused by its passage near or through Neptune's and Triton's atmospheres and through the ring plane.

Dr. G. Len Tyler of the Center for Radar Astronomy at Stanford University, Calif., is team leader.

Ultraviolet Spectrometer

The ultraviolet spectrometer will gather data on the composition of the atmospheres of Neptune and Triton through atomic emission and absorption techniques.

The ultraviolet spectrometer uses a grating spectrometer sensitive to ultraviolet radiation in the range from 500 to 1,700 angstroms. The experiment weighs 9.90 pounds and uses 2 watts of power.

Dr. A. Lyle Broadfoot of the University of Arizona, Tucson, is principal investigator.

Cosmic-Ray Subsystem

The primary function of the cosmic-ray subsystem is to measure the energy spectra of trapped, energetic electrons.

The cosmic-ray subsystem uses seven independent solid-state-detector telescopes. Working together, they cover the energy range from 0.5 million to 500 million electron volts. The cosmic-ray subsystem weighs 16.6 pounds and uses 5.2 watts of power.

Dr. Edward C. Stone of the California Institute of Technology, Pasadena, is principal investigator.

Low-Energy Charged-Particle Detector

The low-energy charged-particle detector (LECP) is designed to characterize the composition, energies and angular distributions of charged particles in interplanetary space and within planetary systems.

Two solid-state particle detector systems are mounted on a rotating platform. The detector's sensitivity to charged particles ranges from 15,000 to more than 160 million electron volts. The LECP weighs 16.5 pounds and draws 4.2 watts of power during encounter operations.

Dr. S. M. (Tom) Krimigis of the Applied Physics Laboratory at Johns Hopkins University, Laurel, Md., is principal investigator.

Magnetic Fields Experiment

The magnetic fields experiment consists of four magnetometers that detect and measure magnetic fields. At Neptune, they will study the interaction of the magnetic field with moons orbiting within it and observe the interplanetary-interstellar magnetic fields in the vicinity of the planet.

Two low-field magnetometers are mounted on a 43-foot boom away from the magnetic field of the spacecraft itself. Two high-field magnetometers are mounted on the spacecraft body to measure fields more than 30 times stronger than that at Earth's surface. The total weight of experiment components is 12 pounds. The experiment uses 3.2 watts of power.

Dr. Norman F. Ness of the Bartol Research Institute at the University of Delaware, Newark, is principal investigator.

Planetary Radio Astronomy Experiment

Voyager 2's planetary radio astronomy experiment (PRA) will search for and characterize a variety of radio signals emitted by Neptune. The PRA will determine the relationship of these emissions to the moons, the magnetic field, atmospheric lightning and plasma environment. The detector also will measure planetary and solar radio bursts from different directions in space and relate them to measurements made from Earth.

The PRA uses two 33-foot electric antennas as detectors, which PRA shares with the plasma-wave subsystem. PRA covers the range from 20 kilohertz to 40.5 megahertz in the radio-frequency band. The instrument weighs 16.9 pounds and uses 6.8 watts of power.

Dr. James W. Warwick of Radiophysics Inc., Boulder, Colo., is principal investigator.

Plasma Subsystem

The plasma subsystem (PLS) studies the very hot ionized gases, or plasmas, that exist in interplanetary regions and within planetary magnetospheres.

At Neptune, the PLS will study the extent and configuration of the magnetic field and the nature and sources of internal plasma. In addition, it will observe the solar wind and its interaction with the Neptune system.

Later in the Voyager Interstellar Mission, the PLS will determine the extent of the solar wind and the nature of the boundary between the solar wind and the interstellar medium.

The PLS consists of two plasma detectors sensitive to solar and planetary plasmas -- both positive ions and electrons -- with energies between 10 and 6,000 electron volts. The experiment weighs 21.8 pounds and draws 8.3 watts of power.

Dr. John Belcher of the Massachusetts Institute of Technology, Cambridge, is principal investigator.

Plasma-Wave Subsystem

Voyager's plasma-wave subsystem (PWS) is designed to measure the electric-field components of local plasma waves. At Neptune, it will measure the density and distribution of plasma, interactions of plasma waves with energetic particles and the interactions of moons and ring arcs with the planet's magnetosphere.

The PWS will provide key information on the phenomena related to the interaction of plasma waves and particles that control the dynamics of the magnetosphere.

Two extendable electric antennas, shared with the planetary radio astronomy experiment, serve as plasma-wave detectors. The system covers the range from 10 hertz to 56 kilohertz. In the normal mode, the PWS acts as a scanner, stepping from one frequency to another. In a second mode at selected times during the encounter, the system can record electric-field waveforms across all frequencies in a broad band (50 hertz to 10 kilohertz).

The experiment weighs 3.02 pounds and uses 1.4 watts of power in the normal step-frequency mode and 1.6 watts in the step frequency-plus-waveform-analyzer mode.

Dr. Donald Gurnett of the University of Iowa, Iowa City, is principal investigator.

VOYAGER 2's HEALTH

The Voyager spacecraft engineering team has learned to cope creatively with several problems the geriatric machine has experienced in its long lifetime. Still, the spacecraft and all of its instruments are in good operating condition.

Malfunctioning Radio

On April 5, 1978, the spacecraft's computer-command subsystem automatically switched to the back-up receiver. The back-up at that point had concealed a problem of its own -- a faulty tracking loop capacitor -- meaning that the receiver could not hold onto the changing frequency of the transmitted signal. This required the ground transmitter to send the precise frequency, taking into account the Doppler shift caused by the relative motion between the spacecraft and Earth, so that it would match the frequency that the receiver on the spacecraft was expecting. That frequency depends on a number of factors, including the receiver's temperature which fluctuates with spacecraft activity. When the prime receiver was turned back on, it failed almost immediately, requiring that the rest of the mission be flown on the tone-deaf back-up receiver.

Voyager engineers have determined how the tuning depends on temperature and how the operation of different subsystems onboard affects the temperature of the receiver. Even so, there is a period after any change in the spacecraft's configuration when it is impossible to know the receiver's temperature with adequate precision. As a result, commands are not routinely transmitted to Voyager after a change in the spacecraft configuration until the receiver's temperature has had time to stabilize.

If need be, controllers can send commands to the spacecraft at different frequencies in rapid succession to ensure that one will be picked up by the receiver. This and other techniques, that work around the crippled receiver, were successfully employed at Jupiter and have been refined further in ensuing years.

There is always a chance that the backup receiver could fail or lose contact with Earth permanently. The Voyager team has planned against this possibility by programming a backup spacecraft computer with simplified encounter routines for execution at Neptune. The spacecraft has been instructed to send data back to Earth even in the event that it loses uplink contact.

The Stuck Scan Platform

In 1981, Voyager 2's scan platform jammed in one axis just after its Saturn encounter. The problem limited pointing of the instruments for the duration of the encounter.

After 2 days, the platform was again movable. Three years of analysis and testing showed that the problem was due to a loss of lubricant from overuse at high speeds, which resulted in damage to a bearing in the high-speed gear train of the platform. The lubricant apparently migrated back into the gear train after a short period of rest and the platform was successfully operated at lower speeds during the Uranus encounter.

The scan platform continues to be fully operable at lower speeds and has operated successfully during the cruise to Neptune. It is expected to operate without problems through the end of the Neptune encounter.

MISSION OPERATIONS

Commands for controlling Voyager 2's systems and operations are sent to the spacecraft in a single beam of radio signals from an antenna at one of NASA's Deep Space Network complexes. The DSN is comprised of large antennas at communications complexes in Spain, Australia and California. One command load of up to 2,500 18-bit words can provide the spacecraft with enough instructions to carry out a sequence of tasks over a period ranging from 2 days to 6 months.

The Voyager science teams determine the observations to satisfy mission objectives. In turn, the Voyager sequence team designs time blocks in which the spacecraft will make the science observations as it concurrently performs engineering and navigation tasks. These sequences are tested in computer-based simulations of the spacecraft to ensure their consistency with the spacecraft's hardware, software and operational constraints.

The Voyager project has maintained nearly the same operating procedures employed during the Jupiter and Saturn encounters, but with about one-third the staff. This has resulted in fewer but longer-running command loads to the spacecraft during interplanetary cruise phases since the Saturn encounter and has limited the number of calibrations performed.

Commands are sent at a rate of 16 bits-per-second through the 230-foot antenna at any one of the three DSN complexes. Traveling at the speed of light, the commands will reach the spacecraft at Neptune in 4 hours, 6 minutes. With the long delay in round-trip communication time, engineers are unable to respond quickly if a spacecraft problem develops. For this reason, the spacecraft's master computer, called the computer command subsystem, has been programmed with a set of stored responses to anticipated problems.

The computer allows the spacecraft to act autonomously, quickly protecting itself from situations that could jeopardize communications or spacecraft operations. The computer command subsystem also contains the back-up mission load, the basic commands that would allow Voyager 2 to conduct rudimentary investigations of Neptune if the spacecraft's radio receiver were to fail.

Occasionally the need arises to change the state of the spacecraft or one of its instruments beyond the scope of the commands already in the spacecraft computer. Commands of this type are called real-time commands and are usually sent for immediate execution by the spacecraft.

The telemetry received at the DSN complexes is transmitted to JPL via wide-band and high-speed data lines. The wide-band lines are used primarily for high-bit-rate science telemetry, while the high-speed lines are used for engineering telemetry and low-bit-rate science collected during the cruise phase.

Overseas lines are routed through NASA's Goddard Space Flight Center, Greenbelt, Md., via satellite links. The Goldstone, Calif., transmissions are sent directly to JPL through ground microwave stations.

Both wide-band and high-speed transmissions are received at JPL by the Network Operations Center, where they are logged on tape and routed in real time to the Mission Control and Computing Center (MCCC). The MCCC is responsible for display, control, decoding and routing of real-time telemetry to the Test and Telemetry System (TTS) and JPL's Multimission Image Processing Laboratory. The TTS displays engineering telemetry in real time for the spacecraft team and the mission control team and processes and displays science data for each of the science teams other than imaging.

Imaging data are transferred to the Multimission Image Processing Laboratory for processing and analysis. Here, the imaging data are decompressed. During this process, the images can be enhanced to bring out subtle features and, in some cases, corrected for errors.

All data from the spacecraft experiments are collected and processed into Experiment Data Records, which contain all available science and engineering data from a given instrument. The records are the final data product forwarded to investigators for analysis. A companion record called the Supplementary Experiment Data Record accompanies the Experiment Data Records and contains the best estimate of the conditions under which the observations were made.

Reducing the Volume of Data

As Voyager travels farther away, the rate decreases, at which the DSN antennas can reliably receive the data. For example, at Jupiter about a half-billion miles from Earth, the highest data rate was 115,200 bits-per-second (bps); at Neptune, 2.5 billion miles away, the data rates will be 21,600 and 14,400 bps.

To increase the amount of data that reliably can be returned, flight engineers have devised ways to reduce the number of bits required to transmit images. These include changing the way the spacecraft encodes the data before sending it, editing and compressing the data.

At Jupiter and Saturn, all science data except imaging was encoded with an error-correcting code that required as many bits of data for the code as there were bits of data. For Uranus, all science data, including imaging, was coded with a more efficient technique to reduce the overhead to about 15 percent. The same coding will be used at Neptune.

Imaging data also may be edited or compressed to reduce the number of bits-per-image. A Voyager imaging frame comprises 800 lines by 800 picture elements (pixels) per line -- a total of 640,000 pixels-per-image. Eight bits express the gray level of each pixel, ranging from 0 (black) to 255 (white). Thus, each image requires 5.12 million bits.

Data compression reduces the bit volume by 60 to 70 percent. The total number of bits needed to transmit an image is reduced, but images still can be returned at full size and full resolution. The edges of "busy" scenes may be jagged.

To compress the data, each line is divided into blocks of five pixels. The absolute brightness of the first pixel in each line is sent, and then the brightness of each of the following pixels is expressed as its difference from the brightness of the preceding pixel.

TELECOMMUNICATIONS

The Deep Space Network, operated by the NASA JPL, has carried out all tracking and communication with the Voyagers since they left the Earth.

DSN stations are located around the world, in multi-antenna complexes at Goldstone, in California's Mojave Desert; in Robledo, near Madrid, Spain; and on the Tidbinbilla Nature Preserve near Canberra, Australia. The three complexes are spaced at widely separated longitudes so that spacecraft can be in continuous view as the Earth rotates.

Each location is equipped with 230-foot antenna (enlarged from 210 feet); one standard and one high-efficiency 112-foot antennas; and a 85-foot antenna.

In addition to the antennas, each of the network's signal processing centers houses equipment for transmission, receiving, data-handling and interstation communication. The downlink radio frequency system includes cryogenically-cooled, low-noise amplifiers.

Uplink

The uplink operates at S-band radio frequency (2,113 megahertz), carrying commands and ranging signals from ground stations to the spacecraft. The 230-foot antenna stations have 400-kilowatt transmitters. Transmitting power for the standard 112-foot stations is 20 kilowatts.

Downlink

The downlink is transmitted from the spacecraft at S-band (approximately 2,295 MHz) and X-band (approximately 8,415 MHz) frequencies. The standard 112-foot antennas and the 230-foot antennas can receive the S- and X-band signals simultaneously. The high-efficiency, 112-foot antennas receive only X-band transmissions.

The signal from Voyager's 20-watt transmitter (about the same wattage as the light bulb in a refrigerator) gets progressively fainter as the spacecraft moves farther away. By the time it reaches Earth, the signal is about 20 billion times weaker than the battery power that runs an ordinary digital wristwatch. To track this faint signal, either larger antennas or more sensitive receivers are needed. In addition, more power (up to 100 kilowatts for Voyager) is needed to transmit to the spacecraft across the vast distance.

Shortly after the Voyager 2 Uranus flyby, the three largest (210 feet in diameter) and most sensitive antennas of the Deep Space Network were systematically stripped of their surfaces and rebuilt to create an even larger (230-foot) receiving area for the incoming signal.

During the Neptune encounter, the 230-foot and 112-foot antennas at each complex will be arrayed so that their combined collecting areas will increase the amount of signal captured. This will improve the potential for high-rate, low-error data return.

At Canberra, the three DSN antennas will be arrayed with the 210-foot Parkes Radio Astronomy Observatory. The Parkes facility, operated by the Congress of Scientific and Industrial Research Organization, is once again critical to spacecraft support during the Neptune encounter. As during the Uranus encounter, the high southern (-23 degree) declination of Voyager 2 will result in long, 12-hour periods during which the spacecraft will be over the Canberra complex and 9 hours over the Parkes antenna. (The shorter viewing time at Parkes is due to antenna pointing constraints.) The quality of data received at the Australian facility also is likely to be higher than that received in California and Spain because of the large distance between antennas, which decreases the risk of data loss due to local weather conditions.

Innovative uses of other, existing equipment, along with the larger antennas, will significantly increase the potential data return from Voyager during its last planetary encounter.

In Japan, the 210-foot Usuda Radio Observatory tracking antenna, owned by the Institute of Space and Astronautical Science of Japan, will join the Canberra station in collecting radio science data during the Neptune and Triton radio occultation experiments.

In the U.S., radio astronomy antennas never before used to track spacecraft have been accepted into service to track Voyager at Neptune. The 27 90-foot antennas of the Very Large Array in Socorro, N.M., operated by Associated Universities, Inc., for the National Science Foundation, will be arrayed with the Goldstone, Calif., tracking station.

VOYAGER MANAGEMENT TEAM

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NASA
National Aeronautics and
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For Release:

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August 11, 1989

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RELEASE: 89-132

TWO PARTIAL RINGS OF NEPTUNE DISCOVERED BY VOYAGER SPACECRAFT

NASA's Voyager spacecraft imaging science team has found two of the long-sought-after ring arcs, or partial rings, thought to exist around Neptune. The arcs were found in photographs returned by the Voyager 2 spacecraft early this morning at NASA's Jet Propulsion Laboratory, Pasadena, Calif.

The two ring arcs apparently are associated with two of the new Neptunian moons also found by Voyager 2 earlier this month. The arcs appear to partially wrap around approximately 45 degrees and 10 degrees, respectively, the planet's equatorial plane. One is about 30,000 miles in length, and the second is about 6,000 miles long.

The first arc, the longer of the two, was seen just outside the moon 1989 N4, which orbits about 38,500 miles from the planet's center or about 23,300 miles from the planet's cloud tops.

The second arc appears to trail the moon 1989 N3 by approximately 90 degrees or about 50,000 miles. That moon orbits Neptune at a distance of about 32,300 miles from the center of the planet or about about 17,000 miles from the planet's cloud tops.

Astronomers have long suspected the existence of such an irregular ring system around Neptune. Data from repeated ground-based observations hinted at the existence of disorderly strands of partial rings orbiting Neptune. Voyager's photographs of the ring arcs are the first photographic evidence that such a ring system exists.

- more -

Voyager scientists said the ring arcs may be comprised of debris associated with the nearby moons or may be the remnants of moons that have been ground down or torn apart through collisions. Close-up studies of the ring arcs by Voyager 2 in coming days should help determine the rings' composition.

More ring arcs are expected to be found as the spacecraft nears the planet, Voyager scientists said.

Discovery of the two arcs when the spacecraft was still about 13 million miles from Neptune gives the Voyager team time to schedule detailed photography of the ring arcs when the spacecraft comes within 3,000 miles of the planet on Aug. 24 and 25.

The Voyager mission is conducted by the Jet Propulsion Laboratory for NASA's Office of Space Science and Applications.

- end -

NASA News

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For Release:
August 16, 1989

N89-60

EDITORS NOTE:

AUG. 18 GALILEO BRIEFING CANCELLED; SPACECRAFT SHOWING RESET

A Galileo spacecraft press briefing, scheduled for Aug. 18 at the Kennedy Space Center, Fla., has been cancelled.

The briefing was to accompany a viewing of Galileo and its Inertial Upper Stage (IUS) at the Vertical Processing Facility. However, a ground support equipment problem made it necessary to alter the processing schedule and forced the rescheduling of the press viewing opportunity to the afternoon of Aug. 20.

The exact time of the press showing has not yet been set. Project officials will be available to discuss Galileo/IUS processing at KSC and there is a possibility of STS-34 flight crew participation. News media interested in more details about this event should call the KSC Newsroom at 407/867-2468.

The press briefing was cancelled to avoid conflict with a Galileo briefing to be held at noon EDT, Aug. 20, at the Jet Propulsion Laboratory, Pasadena, Calif.

- end -

NASA News

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For Release:
August 16, 1989

RELEASE: 89-133

ANTENNA IN JAPAN TO AID VOYAGER'S RADIO SCIENCE STUDY OF NEPTUNE

A tracking station in Japan has been added to the network of giant antennas trained on NASA's Voyager 2 during its flyby of Neptune on August 25 to help the spacecraft mission's radio science experiment.

Scientists say they will be able to "see" twice as deeply into the atmosphere of the giant gas planet, thanks to the participation of the 210-foot antenna at Japan's Usuda Deep Space Center.

The collaboration was arranged through an agreement signed in 1988 between NASA and Japan's Institute of Space and Aeronautical Studies (ISAS), which operates the Usuda center. Under the agreement, physicist Dr. Nobuki Kawashima of ISAS will join the Voyager Radio Science Team.

"Using Usuda will allow us to extract information on deeper parts of Neptune's atmosphere," said Dr. Len Tyler of Stanford University, principal investigator for the Voyager radio experiment. "Also, the quality of the data we will have for any given point will be twice as good."

During these observations, scientists will listen not to the information carried by Voyager's radio signal but rather to the signal itself -- especially its strength and frequency -- as the spacecraft sails over Neptune's north pole and dips behind the planet .

Barely perceptible changes in the radio signal convey signatures of the structure, composition and temperature of the seas of gases that constitute Neptune's atmosphere, as well as the planet's gravity field.

- more -

As the spacecraft disappears behind a planet or moon from the Earth's point of view, its radio signal is refracted, or bent, during passage through the planet's or moon's atmosphere.

Tiny changes in the signal's frequency and strength give scientists a portrait of the atmosphere's structure, composition, temperature and location of clouds, as well as information on small-scale atmospheric dynamics.

Tyler likened the refraction effect to how a sunset appears on Earth, as the Sun seems to linger at the horizon before it disappears. "You would think that the Sun would appear to keep moving. But because its light is being refracted, you can continue to see it as the Sun seems to stand still for a few moments," he explained.

In addition to studying atmospheres of planets and moons, scientists have used the Voyagers' radio systems during the mission to investigate the rings surrounding planets. As the spacecraft flies behind a ring system, changes in the radio signal provide information not only on the rings' overall dimensions but also on the particles that constitute the rings.

Also, the radio experiment is able to detect minute changes in Voyager's velocity as it curves past each planet, offering a detailed look at the planet's gravity field.

Some of the most significant findings from the radio experiment during the 12-year Voyager Mission have included revelations on the nitrogen atmosphere surrounding and the surface pressure at Saturn's largest moon, Titan; measurements on wave-like structures within Saturn's sprawling rings and the sizes of particles that constitute them; detection of a methane cloud layer in the atmosphere of Uranus; and the nature of Uranus's coal-black rings.

The experiment also has provided data on the densities of moons at planets the Voyagers have visited, as well as the planets' gravity fields. In concert with the Voyagers' infrared interferometer spectrometer and radiometer instrument, the radio science experiment additionally has determined the ratio of hydrogen to helium, the two overwhelmingly dominant elements in the atmospheres of each of the planets.

As Voyager 2 headed into the outer solar system, its radio signal received at Earth became fainter. During the Neptune flyby, the signal strength at Earth will be 1/36th of what it was when the Voyagers flew by Jupiter. The collaboration with ISAS will help offset the diminished signal, Tyler explained.

- more -

During Voyager 2's closest approach to Neptune, radio science data will be recorded at NASA's Deep Space Network station in Canberra, Australia; at the Parkes Radio Observatory in Australia; and at the Usuda center in Japan.

Each receiver is linked to an atomic clock which gives an exceedingly precise time-stamp to the received radio signal. This allows the recorded signals from all the stations to be combined later so that they mesh closely, with the peaks and troughs of the radio waves matching almost exactly.

The combined signal then is analyzed to yield the experiment's science data. Factors such as the chemistry and temperature of a planet's atmosphere will have minute, but measurable, effects on the signal's frequency and strength.

Tyler noted that his team studies frequency changes that amount to only one one-hundredth of a cycle per second in a signal from Voyager 2 being transmitted at a frequency of billions of cycles per second. That is similar, he said, to measuring a change in position of 1/25th of an inch from an observing position 3 billion miles away.

"The best ear of any trained musician can detect a change of a partial musical step, which is some number of cycles per second," Tyler added. "Needless to say, the changes we study in Voyager's radio signal are much more subtle than that."

Opened in October 1984, the Usuda Deep Space Center is set in the mountains of Japan's Nagano Prefecture at 4,777 feet above sea level, some 60 miles northwest of Tokyo.

In addition to performing tracking, telemetry and commanding for Japan's solar system missions, such as the Suisei and Sakigake spacecraft which flew by Comet Halley in 1986, the Usuda center supports experiments involving sounding rockets and balloons.

The Deep Space Network, which includes complexes in the California desert and Spain in addition to the Australian site, is managed by the Jet Propulsion Laboratory for NASA's Office of Space Operations. The Parkes Radio Observatory in Australia is operated by the Commonwealth Scientific and Industrial Research Organization.

JPL manages the Voyager Project for NASA's Office of Space Science and Applications.

- end -

NASA News

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For Release:
August 18, 1989

RELEASE: 89-134

VOYAGER SPACECRAFT DETECTS RADIO EMISSIONS FROM NEPTUNE

NASA's Voyager 2 spacecraft has detected intense radio emissions from Neptune, indicating that the planet has a magnetic field.

The discovery, made by Voyager 2's planetary radio astronomy instrument team at NASA's Jet Propulsion Laboratory, Pasadena, Calif., greatly increases the likelihood that the spacecraft will discover a wide range of interesting phenomena related to a magnetic field, such as aurora and possible radiation-darkened ring arcs and moons.

The emissions are generated around planets by high-velocity, charged particles as they spiral along magnetic field lines into the planet's atmosphere.

At Neptune, "the radio emissions are very intense, very impulsive and occur in a limited range of frequency," said Dr. James Warwick, principal investigator on the planetary radio astronomy experiment. The emissions, he added, are polarized, "so we know we're dealing with a magnetic field. The source is not lightning. It is related to energetic particles interacting in a magnetic field."

A planetary magnetic field is a girdle of magnetic field lines that surround a planet. Such fields are thought to be generated by fluid motion in a planet's core (molten iron in Earth's core, for example). Mercury, Earth, Jupiter, Saturn and Uranus have magnetic fields, while Venus and Mars do not. Whether Pluto has one or not is not known.

- more -

While the Neptunian radio emissions only were confirmed today, Warwick said that in looking back over Voyager data, the emissions were heard by the planetary radio astronomy instrument as early as Aug. 14. The emissions were not immediately recognized as being associated with Neptune, however, because their character "was so different from what we were expecting," Warwick said.

Early analysis indicates that Neptune's magnetic field is of an intensity similar to the magnetic fields of Earth and Uranus.

Voyager 2's close flyby over Neptune's northern hemisphere will allow the spacecraft's complement of instruments to determine Neptune's magnetic field structure and orientation.

As more data from the instrument is returned to Earth over coming days, Warwick's team will be able to precisely define Neptune's rotation -- the length of its day.

Voyager 2 will come within 3,000 miles of Neptune at 12 midnight on Aug. 24.

The Voyager mission is conducted for NASA's Office of Space Science and Applications by the Jet Propulsion Laboratory.

- end -

NASA News

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For Release:
August 24, 1989
4:30 p.m. EDT

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RELEASE: C89-P

MSFC CONTRACTS FOR PURCHASE OF 60 SPACE SHUTTLE EXTERNAL TANKS

NASA's Marshall Space Flight Center, Huntsville, Ala., today awarded a $1.797 billion contract modification to the Martin Marietta Corp., New Orleans, La., to produce 60 additional Space Shuttle external tanks for delivery during the 1990s.

The award is the second portion of a procurement to obtain the tanks. The first portion, awarded to Martin Marietta in June 1988, was for the long-lead hardware (parts and materials) needed for manufacture of the tanks.

The tanks will be produced by Martin Marietta's Manned Space Systems Co. at NASA's Michoud Assembly Facility near New Orleans. The first tank to be built under the new contract is expected to be completed in late 1991 and the 60th in mid-1997. They are slated for use with Shuttle missions STS-60 through STS-119. Under previous awards, 59 tanks have been contracted for to support Shuttle operations, and 52 have been produced to date.

The external tank carries the Shuttle's liquid hydrogen fuel and liquid oxygen oxidizer and supplies them under pressure to the orbiter during lift-off and ascent. The largest and heaviest Shuttle element when loaded, the tank is the only major non-reusable element of the Shuttle system.

- end -

NASA News
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For Release:
August 24, 1989

N89-61

EDITORS NOTE: STS-34 BACKGROUND BRIEFINGS SET

The background briefings and astronaut press conference for STS-34, the Oct. 12 flight of Space Shuttle Atlantis, are scheduled for Sept. 5 and 6 at the Johnson Space Center, Houston.

STS-34 will deploy the Galileo spacecraft to study the planet Jupiter.

A mission overview with the lead flight director and Galileo spacecraft mission manager will begin at 1:30 p.m. EDT, Sept. 5, followed at 3 p.m. by a briefing from the Galileo mission scientist of the scientific observations to the made by the planetary probe. Briefings on other STS-34 payloads and experiments will follow.

The astronaut crew of STS-34 will hold a press conference at 11:15 a.m. EDT, Sept. 6.

All briefings will be carried live on NASA Select television via Satcom F2R, transponder 13, 72 degrees west longitude. Two-way question and answer capability will be available at NASA Headquarters, Washington, D.C., the Jet Propulsion Laboratory, Pasadena, Calif., the Kennedy Space Center, Fla., and the Marshall Space Flight Center, Huntsville, Ala.

- end -

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For Release
August 31, 1989

C89-Q
NASA JOHNSON CONTRACTS FOR ENGINEERING COMPUTATION FACILITY

NASA's Johnson Space Center (JSC), Houston, has entered into a contractual agreement with Grumman Data Systems Corporation, Woodbury, N.Y., for an Engineering Computation Facility (Class VI Computer System). The system will be located in JSC's Building 46 Computer Facility.

The firm-fixed-price contract is for the period of Aug. 25, 1989, through Sept. 30, 1990, with a value of $11,118,323. If all subsequent options are exercised, the total firm-fixed-price will be $47,682,033, for a period not to exceed 60 months.

The contract is an agreement for lease-to-ownership of the Class VI system and includes installation and integration of the system components, as well as analyst support services. NASA will own the equipment in the event that the renewal options are exercised.

The contract was awarded as a result of conversion of a two-step invitation for bid to a single source negotiated procurement.

The Engineering Computation Facility, "a supercomputer," was acquired by JSC for engineering analysis and numeric simulation in the areas of stress, fluid dynamics, thermodynamics, aerodynamics, guidance, navigation and control of large spacecraft structures.

The use of this supercomputer will allow JSC's engineering and scientific staff to improve their computational capability by reducing calculation times significantly. The resulting improved analyses techniques will provide better definition of expected loads and help increase spacecraft performance, which may result in larger payloads and higher orbits.

-end-

NASA News

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For Release:
August 31, 1989

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RELEASE: 89-135

CONTRACTS AIM AT BREAKTHROUGHS IN AIRCRAFT COMPOSITE STRUCTURES

NASA has awarded initial research and development contracts with a potential value of $89 million to 15 aerospace companies and universities as part of the newly established Advanced Composites Technology (ACT) program.

Recognizing the importance of developing new, high-strength plastics to maintaining U.S. leadership in the manufacture and sale of commercial airliners, NASA is seeking technology breakthroughs in these materials. Such breakthroughs would allow structures made of epoxy-type resins and high-strength carbon fiber to replace metal in the wings and bodies of future transport aircraft.

Extensive use of such "composite" components can reduce structural weight by 40-50 percent, purchase cost by 20-25 percent and the number of individual parts by half. "Composites are the key to maintaining our lead in the transport aircraft industry," said Charles Blankenship, director for structures at NASA's Langley Research Center, Hampton, Va. "The U.S. share of the transport aircraft manufacturing market has been declining since 1970."

Composite materials have demonstrated large weight savings for aircraft structures and outstanding corrosion and fatigue damage resistance. Despite these advantages, the full potential benefits of composites have been limited by the high cost of materials, labor-intensive manufacturing processes and inadequate technology in structural mechanics and materials science.

- more -

NASA's researchers hope for breakthroughs in structural concepts, materials and fabrication techniques. The technology developed through the agency's efforts will be transferred to U.S. government agencies and to the American aircraft industry. To help meet these ambitious objectives, NASA is asking industry, government and universities for "innovative ideas for the efficient and cost-effective use of lightweight composite materials" in aircraft manufacturing. The ACT program is an important part of the overall composites effort.

The development of a solid structural mechanics technology data base will make the ACT objectives attainable. It will provide scientific understanding of failure mechanisms and establish true limits of performance so that design and analysis procedures may be applied to an airplane's primary structures. Currently, transport aircraft use composite materials only in secondary structures such as control surfaces, spoilers and trailing edge panels.

The multiple-year program will be managed by Langley, under the overall direction of NASA's Office of Aeronautics and Space Technology, NASA Headquarters, and will be conducted in three major phases.

Phase I is called the "technology innovation" phase. It will last about 36 months, and will focus on basic research in materials and structures to define and develop unique and innovative structural concepts that fully exploit the potential benefits of composites, yet are efficient and cost-effective.

Phase II, the "technology development" phase, also is slated to last 36 months, with the major thrust beginning about mid-1991. It will concentrate on the most promising concepts evolving from Phase I for scale-up to element and component-level tests and analyses that will provide the basis for an integrated technology data base.

The first two phases are designed to provide the fundamental technology necessary for Phase III (the "verification" phase), a currently unfunded part of the program with a planned duration of three to four more years. Phase III represents a significant effort to establish cost and weight effectiveness on full-scale components. This part of the ACT program would establish affordable technology for the development of transport and fighter aircraft primary structures by the mid-1990's.

Funding for the first two phases totals $142 million, including the following recently awarded contracts: Boeing Commercial Airplanes, $22.6 million; Lockheed Aeronautical Systems Company, $22.5 million; McDonnell Douglas Corporation, $23.7 million; Northrop Corporation, $5.2 million; Grumman Aircraft Systems, $2.7 million; Sikorsky Aircraft Division, $1.1 million; Dow Chemical Company, $6.0 million; Hercules Aerospace Corporation, $1.1 million; University of Utah, $.8 million and $.2 million; BASF Structural Materials, Inc., $1.8 million; Stanford University, $.5 million; Rockwell International, $.4 million; University of Delaware, $.3 million; and University of California at Davis, $.2 million.

About 60 percent of the program will be implemented through these contracts, and additional contracts are planned for emerging opportunities in advanced composite materials and structures technologies that have high potential for aircraft applications. In addition, in-house research at both Langley and NASA Lewis Research Center, Cleveland, will represent a significant part of the program.

- end -

Photographs are available to illustrate this release by calling 202/453-8375

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89-HC-455	89-H-458

NASA News

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RELEASE: 89-136

NASA DESIGNATES 17 SPACE GRANT COLLEGES/CONSORTIA

NASA today announced the selection of 17 universities and consortia as Designated Space Grant Colleges/Consortia in the first element of NASA's new National Space Grant College and Fellowship Program.

The program was mandated by Congress in 1987. Its first element names certain schools or consortia of schools as Designated Space Grant Colleges/Consortia. These designated institutions, which are already significantly involved in space-related activities, will receive grants and fellowships. The designated colleges/consortia were selected based on a competitive evaluation of the institutions' existing aerospace activities as well as the quality of their plans to strengthen the national educational base for science, math and technology.

The original program announcement forecast the number of expected space grant college designations as no more than 12, due to anticipated budget limitations. However, NASA Administrator Richard H. Truly decided to extend designations to 17 colleges/consortia in response to the high quality of the proposals received and as an indicator of NASA's desire to get this important program off to a strong start.

Truly said, "I expect this program to have a very significant educational impact throughout the nation, by enhancing the training of future scientists and engineers at the university level, as well as by improving the teaching of science, mathematics and technology at the elementary and secondary levels."

The Designated Space Grant Colleges/Consortia will provide leadership and form partnerships with other universities, government and industry to better understand, develop and use space resources through research, education and public service functions.

- more -

The 17 designated universities and consortia, listed in alphabetical order, are: Alabama Space Grant Consortium; Arizona Space Grant College Consortium; California Space Grant Consortium; Colorado Space Grant Consortium; Cornell Space Grant Consortium; Florida Space Grant Consortium; Georgia Institute of Technology Grant Consortium Fund; Aerospace Illinois Space Grant Consortium; The Johns Hopkins Space Grant Consortium; Massachusetts Institute of Technology; Michigan Space Grant College Program; Ohio Aerospace Institute; Pennsylvania State University; Rocky Mountain Space Grant Consortium; Texas Space Grant Consortium; Virginia Space Grant Consortium; and the University of Washington. NASA expects to designate additional Space Grant Colleges/Consortia in future years as funds become available and as schools expand their capabilities in the space area.

These Designated Space Grant Colleges/Consortia will receive funding for 5 years. In fiscal year 1989 each designee will receive $75,000. In subsequent years, the institutions will receive up to $225,000 per year and are expected to obtain, as a minimum, matching non-Federal funds. In addition, these designated institutions will receive $100,000 funding to support fellowships for undergraduate and graduate students beginning in fiscal year 1990.

"The National Space Grant College and Fellowship Program will help maintain America's leadership in aerospace research, training and education," Adm. Truly said. "The investment in these universities and consortia will greatly impact and nourish all levels of education. I am very pleased with the growing aerospace education programs and the strong desire of universities to expand and coordinate these activities. In light of the President's recently announced space exploration initiative, this program will be key to attracting and developing future generations of the most talented engineers and space scientists."

The National Space Grant College and Fellowship Program comprises three elements: (1) designation of Space Grant Colleges/Consortia which will provide for a national network of universities and colleges; (2) awards to support space grant programs at other institutions that will expand participation of colleges/universities/consortia that have not been as extensively involved in aeronautics and space research and education; and (3) space grant fellowships that will be made available to students at institutions selected in the first two elements. The first of the elements is the subject of this announcement. The second and third elements of the National Space Grant College and Fellowship Program will be initiated in fiscal year 1990.

A list of consortium institutions can be obtained by phoning the NASA Headquarters Newsroom on 202/453-8400.

- end -

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For Release
September 1, 1989

C89-R

GSFC OPERATIONS AND MAINTENANCE SERVICES CONTRACTOR SELECTED

NASA's Goddard Space Flight Center, Greenbelt, Md., has awarded a cost-plus-award-fee contract, through the Small Business Administration's Section 8 (a) program, to E. L. Hamm and Associates, Inc., Norfolk, Va. This contract provides centerwide plant operations and maintenance services.

The contract is effective Sept. 1, 1989, and consists of a 1-year basic contract period with four 1-year priced options. The 5-year total estimated cost, including base fee and maximum award fee, is $32,216,742.

The contractor will operate and perform broad and comprehensive plant operations and maintenance services for all facilities and equipment located at the Goddard Space Flight Center. The effort includes, but is not limited to, project management, building operations and maintenance, special operations and maintenance, alterations and modifications and work reception and management.

- end -

NASA News

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For Release:
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RELEASE: 89-137

INTELSAT SELECTED FOR USE OF TDRS C-BAND

NASA today concluded an agreement with INTELSAT, Washington, D.C., for the use of the C-band capacity on two Tracking and Data Relay Satellites (TDRS) for international telecommunication purposes. INTELSAT may initiate testing and C-band services upon the completion of NASA's final operational preparations later this year.

NASA received bids for the C-band services on July 7, 1989. The bids resulted from a June 12, 1989, solicitation package from NASA's Office of Space Operations, Washington, D.C., in which 11 organizations expressed interest.

In return for its bid of $51 million, INTELSAT will have the use of 24 C-band transponders on the TDRS satellites at 41 degrees and 171 degrees West longitude, utilizing the C-band service for a period of 6 years. Each satellite has twelve 36-MHZ C-Band transponders available.

NASA will provide station-keeping control to 0.1 degree and perform operational tracking, telemetry and command for the spacecraft.

The two TDRS spacecraft are part of NASA's new space-based network for tracking and communication with the Space Shuttle and other spacecraft in low-Earth orbit.

-end-

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For Release:

September 6, 1989

RELEASE: 89-138

U.S.-U.S.S.R. LIFE SCIENCE INVESTIGATIONS TO BE LAUNCHED

More than 85 NASA-sponsored researchers from 19 states and three foreign countries are participating in 29 cooperative investigations on a Cosmos biosatellite mission to be launched by the Soviet Union on September 8, 1989.

The Cosmos biosatellite is an unpiloted recoverable spacecraft that accommodates plant and animal experiments. Cooperative investigations on the 14-day Cosmos '89 mission will address questions related to the biomedical effects of prolonged space flight. Biological specimens on the mission include rhesus monkeys, rats, fish, fish eggs, newts, drosophila, beetles, seeds, unicellular organisms and planaria. Investigations cover bone and muscle alterations, circadian rhythms and thermoregulation, neurophysiology, radiation biology and gravitational biology.

Nearly 3,000 biological samples from the Cosmos '89 mission's flight and control groups of subjects will be returned to laboratories across the United States for analysis. Many of the cooperative U.S.-Soviet investigations on this mission will expand upon investigations flown on previous Cosmos missions. The last Soviet biosatellite mission, Cosmos 1887, launched on September 29, 1987, was a 13-day mission that involved 60 U.S. investigators in cooperative experiments. Results of these investigations were announced at a science symposium in Moscow in late 1988. Data were obtained on radiation dosimetry; changes in rodent bone, muscle, and organs; and bone tissue calcium loss in primates.

-more-

The Cosmos '89 mission is the seventh Soviet biosatellite mission in which NASA has participated. The U.S.S.R. also has invited the United States to participate in cooperative investigations on a 1992 Cosmos mission. A NASA Research Announcement released in June 1988 solicited proposals for participation in the 1989 and 1992 Cosmos missions.

NASA's space medicine and biology program has benefited from scientific cooperation with the U.S.S.R. on Cosmos missions through the opportunity to conduct experiments with animal subjects on the effects of long-duration flights.

U.S. participation in Cosmos investigations is currently coordinated by the U.S.-U.S.S.R. Joint Working Group on Space Biology and Medicine, established under the U.S.-U.S.S.R. Space Science Cooperation Agreement signed in April 1987.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202-453-8400

For Release:

Lisa Fowler
Kennedy Space Center, Fla.
(Phone: 407/867-2468)

Nancy Lovato
Ames-Dryden Flight Research Facility, Edwards, Calif.
(Phone: 805/258-8381)

EDITORS NOTE: STS-34 NEWS MEDIA ACCREDITATION

NASA is accepting accreditation requests for news media to cover the Space Shuttle Atlantis mission (STS-34), currently targeted for launch no earlier than October 12.

All news organizations wishing to send representatives to cover STS-34 must send a letter requesting accreditation for the mission. Previous requests for credentials do not apply to subsequent missions and new letters must be submitted.

Requests for credentials, launch through landing, should be submitted to:

NASA John F. Kennedy Space Center
PA-PIB/Accreditation
Kennedy Space Center, FL 32899

Please indicate the NASA location(s) from which you plan to cover the mission. Media planning to cover the landing only should submit their requests for accreditation to:

NASA Ames-Dryden Flight Research Facility
Attn: DXI/Public Affairs
P.O. Box 273
Edwards, CA 93523

- more -

Requests for accreditation must be made by a supervisory official other than the applicant on company letterhead, clearly indicating the assignment (reporter, photographer, technician, etc.) and social security number of each individual. Freelance writers and photographers must offer proof of assignment or evidence of past professional activity. The accreditation will be valid for all NASA news centers.

NASA ground rules for newspersons covering the mission are:

o NASA can make no travel or housing arrangments.

o Only working newspersons will be accredited at the news centers. Publishers and other news and advertising executives will not be accredited. These individuals should apply to NASA Public Services Division (LP), NASA Headquarters, Washington, D.C., 20546.

o Friends, dependents or relatives not covering the mission will not be accommodated.

o No one under 16 years of age will be allowed at the press site under any circumstances. Violation of this rule will result in cancellation of press site privileges for responsible parties.

o Philatelic publications must meet the criteria for general publications or be national publications of recognized philatelic organizations. Representatives of catalogs, newsletters, local clubs or profit seeking projects will not be accredited. Conducting philatelic business, other than reporting, is not permitted.

o College news media are limited to two accredited correspondents.

o You must present your letter of acceptance and a photo identification to obtain a news media badge at the appropriate center.

o Violations of the rules will result in loss of press badge and press site privileges.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202-453-8400

Jim Cast
Headquarters, Washington, D.C.
(202/453-8536)

Mack Herring
Stennis Space Center, Miss.
(Phone: 601/688-3341)

For Release:
4 p.m. EDT
September 5, 1989

C89-S

CONTRACTOR NAMED FOR CONSTRUCTION MANAGEMENT OF NEW TEST FACILITY

NASA has selected Fluor Constructors International Inc., Irvine, Calif., for final negotiations for a contract to provide construction management services for the Component Test Facility at NASA's John C. Stennis Space Center, Hancock County, Miss.

The proposed cost-plus-award fee contract covers an estimated 3-year period. It is anticipated that the contract will be initiated this month and have a total estimated value of approximately $17 million, which includes $13.5 million in equipment and material subcontracts.

Services covered by the contract consist of providing professional construction management services that will encompass project management, procurement/contracts administration, supervision and inspection of construction, facility testing, operating and maintenance, quality assurance and safety.

The test facility is being constructed at Stennis to test high-fidelity turbopump assemblies for the proposed heavy-lift Advanced Launch System (ALS) being jointly developed by NASA and the U.S. Air Force. The main objective of the ALS program is to design a robust, highly reliable vehicle to carry heavier payloads much more cost effectively than existing expendable launch vehicles (Titan, Atlas, Delta) or the Space Shuttle.

Stennis is responsible for testing efforts that will demonstrate highly reliable, low-cost engine components for the liquid-fueled engines and propulsion systems planned to power the ALS vehicle.

- end -

NASA News

National Aeronautics and
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Washington, D.C. 20546
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For Release:

James Ball
Headquarters, Washington, D.C.
(Phone: 202/453-2927)

Sept. 7, 1989

Laurance A. Milov
Ames Research Center, Mountain View, Calif.
(Phone: 415/694-6221)

RELEASE:89-139

NASA ANNOUNCES COLLABORATIVE RESEARCH PROJECT WITH GENENTECH

NASA's Ames Research Center, Genentech, Inc., South San Francisco, Calif., and Penn State's Center for Cell Research, today announced their long-term collaboration on a major new commercial space research project in life sciences.

The project involves a series of ground-based and Space Shuttle experiments to expand previous findings by NASA, Penn State , and other investigators that microgravity accelerates reduction in bone calcium, body mass and immune cell function.

The flight program, sponsored by NASA's Office of Commercial Programs and managed by Ames, is expected to begin in 1990 with a Space Shuttle experiment coordinated by Penn State
s Center for Cell Research, one of NASA's 16 Centers for the Commercial Development of Space (CCDS).

NASA-Ames, Genentech and Penn State believe that, along with its commercial and scientific validity, this experiment program will increase the fund of medical knowledge to treat human bone diseases, organ regeneration and transplantation as well as immune and skeletal muscle cell deficiency here on Earth. The research also will provide further evaluation of the function of tissues to gain more specific information about space flight's effect on the body.

For companies such as Genentech, early identification of medically important compounds could provide a competitive advantage in the international marketplace, enhancing the U.S. position as international leader in biotechnology while furthering the federal mandate to expand commercial user of space.

- more -

Private business participation in this program also helps offset the cost of space exploration and research as the private and public sectors gear up for development of the Space Station Freedom and human planetary exploration.

James T. Rose, NASA Assistant Administrator, Commercial Programs, said, "The scientific initiative and cooperation of NASA-Ames, Genentech and Penn State enable us to announce today a major new, commercially supported scientific study in space. Through these cooperative efforts with the business and academic communities, NASA pursues scientific discoveries that can benefit all the world's people while strengthening America's economic base and international competitive position."

G. Kirk Raab, Genentech president and chief operation officer, said, "Genentech is proud and excited to be one of the first biotechnology companies to carry out space-based research. Our collaboration with NASA and Penn State grew out of an interest in cell and tissue changes measured after space flight and our high regard for the capabilities and technologies of both groups of scientists. We hope our combined efforts will provide greater understanding of human disorders."

Genentech expressed strong interest in the potential for faster, more economical manufacturing of its products in a space environment.

Penn State's Center for Cell Research, University Park, Pa., is a co-investigator in this research and is exchanging information, expertise and flight experience with Genentech in addition to offering the company an opportunity to fly space experiments as part of the CCDS mandate.

The center, established in 1987, is one of only three biologically oriented CCDSs. It is charged with making flight opportunities available to commercial organizations through the broad-based research collaboration conducted by the center's 35 scientists.

Dr. Wesley Hymer, CCR center director, said, "Our objective is not only to define the fundamental mechanisms of mammalian cell function on earth and in space, which is basic research, but also to commercialize our findings in cooperation with private industry. We're pleased to be part of this innovative research project and expect that it's only the first of many in cooperation with the private sector."

The CCDSs were established as part of a policy to create commercial opportunities in space as a means of assuring continued U.S. space leadership.

Dale Compton, NASA-Ames action director, said, "This collaboration with Genentech and Penn State places NASA-Ames in the forefront of space commercialization. After 20 years of NASA experimentation on the general effects of microgravity on mammals, the Genentech-Penn State venture will focus on specific medical problems in hopes of validating long held hypotheses."

- end -

For Release:

Sept. 8, 1989

Terri Sindelar
Headquarters, Washington, D.C.
Sept. 13, 1989
(Phone: 202/453-8400)

RELEASE: 89-140

STUDENT FINALISTS TO PRESENT SPACE STATION PROPOSALS

Eight high school students will present proposals for Space Station Freedom experiments as national finalists of the 9th Annual Space Science Student Involvement Program (SSIP). The program, co-sponsored by NASA and the National Science Teachers Association (NSTA), gives high school students the opportunity to propose experiments which theoretically could be conducted in space. Students will compete for scholarships and other awards.

In addition to these eight students, two national student newspaper competition winners and three Destination Mars proposal competition winners will be honored during the NASA/NSTA National Space Science Symposium, Washington, D.C., Sept. 14-16. Key events follow:

Thursday, Sept. 14, eight student finalists will present experiment proposals to a panel of scientists and educators at the Columbia Ballroom, Capitol Holiday Inn, 550 C St., S.W. Also attending will be 50-100 students from Washington-area magnet schools and NASA's adopted schools.

Students and their teacher/advisor will attend a Thursday evening reception at the National Air and Space Museum. Guest speakers will include James R. Thompson, NASA Deputy Administrator: Dr. Robert W. Brown, Director of Educational Affairs, NASA; Dr. Hans Anderson, NSTA President; Dr. Helenmarie Hofman, SSIP Director, NSTA; and Dr. James Sharp, Assistant to the Director of the National Air and Space Museum. Members of Congress and Representatives from the aerospace industry and educational associations have been invited.

Friday, Sept. 15, students tour the Capitol and meet their congressmen. During a noon awards luncheon, NSTA will announce the national scholarship recipients and recognize the Destination Mars team and newspaper competition winners at the Washington court,

- more -

525 New Jersey Ave., N.W. Guest speaker is Senator Albert Gore, Jr., (D-TN), Chairman, Senate Subcommittee on Science Technology and Space. Also speaking is Lloyd Bruce, former SSIP winner whose experiment flew on Space Shuttle Mission 26.

Selected from more than 1,600 proposals, the following names the eight national student finalists and their proposal topics, tow student newspaper competition winners and three Destination Mars team members:

SPACE STATION PROPOSAL FINALISTS

Bianco Santomasso, New York City. Topic: "Determining the Effect of Microgravity on New Circulation to the Hands and Feet in Humans through the Measurement of Nail Growth.:

Rebecca Glasar, West Allis, Wisc. Topic: "The Effects of Fluoride-Calcium Therapy on Bone Decalcification in Microgravity."

Mark G. Baxter, Durham, N.C. Topic: "The Effects of Microgravity on the Membrane Transport System of ______________"

Antonio Algaze-Beato, San Juan, P.R. Topic: "The Effects of Microgravity in the Human Circulatory System."

Ronnie E. Raney, Lenexa, Kan. Topic: "Application of Estrogen Replacement, Calcitonin, to the Problem of Calcium Depletion in a Micro-gravity Environment."

Sabry G. Mansour, Los Angeles, Calif. Topic: "The Effects of Space Environment on the Regeneration Rate and Healing Success of Severed Vagus Nerves of Architeuth Princeps."

Amy E. Ksir, Laramie, Wy. Topic: "Chaotic Patterns of Mixed fluids in Microgravity."

Diane M. Fogel, Lansdale, Penn. Topic: "The Effects of Calcitonin in Establishing Calcium Homeostasis in Microgravity."

NATIONAL STUDENT NEWSPAPER AWARD WINNERS

News Feature: Allen Chen, Columbus, Ind.
Advertisement: Paul Michael Schumacher, Yuma, Arizona

PILOT PROGRAM: "DESTINATION:MARS" - TEAM COMPETITION

Eric Bauer, Andrew Thoma and Roger Baker of Mechaniscsburg Area Senior High School, Mechanicsburg, Penn.

The SSIP competition objective is to stimulate interest in science and technology by directly involving students in a space research program. Since NASA's resumed space flight in September 1988, four student experiments have flown on the Shuttle. To date, 19 SSIP experiments have flown aboard the Shuttle. An SSIP experiment proposed by Tracy Peters is manifested for Space Shuttle mission 34, scheduled for launch Oct. 12, 1989.

- end -

NASA News

National Aeronautics and
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Washington, D.C. 20546
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For Release:
September 14, 1989

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Franklin O'Donnell
Jet Propulsion Laboratory, Pasadena, Calif.
(Phone: 818/354-5011)

RELEASE: 89-141

NASA MOBILE COMMUNICATIONS SYSTEM FIELD TESTED

A complete system for mobile communications has been fieldtested for the first time by researchers from NASA's Jet Propulsion Laboratory (JPL), Pasadena, Calif.

A fully developed system would use satellites to extend mobile telephone services to remote ground users and to users in the air and at sea who cannot be served by cellular telephone systems. Such a system also could serve such users as private drivers, cross-country trucks, forestry personnel and law enforcement agents.

The field tests were made possible by the cooperation of AUSSAT Pty. Ltd., the Australian national satellite system, which provided local facilities used in the experiments.

The experiments, conducted in July and August 1989, involved communications between a base at AUSSAT's downtown Sydney, Australia, facility and a mobile unit mounted in a van. The system evaluated in the tests uses vehicle antennas, voice encoders and other hardware developed by JPL under its Mobile Satellite Experiment (MSAT-X) program for NASA.

"Our conclusion was that the system really will work," said Dr. William Rafferty, manager of JPL's Communications Section. Both voice and data calls were tested during the experiments, he said.

During the tests, the mobile unit ranged as far away as the city of Brisbane, more than 450 miles north of Sydney. That is approximately the distance between Los Angeles and San Francisco or between New York City and Detroit. According to Rafferty, routes followed by the mobile unit took it behind trees, under bridges and around other obstructions, with no loss of synchronization, during calls lasting more than 2 hours each.

- more -

Calls were relayed over Japan's Experimental Technology Satellite-V. When fully operational, mobile communications systems would use special, dedicated Earth-orbiting satellites.

Under the MSAT-X program, JPL has been developing technologies for mobile satellite systems, including mechanically and electronically steered vehicle antennas, modulation encoding and networking methods.

This summer's tests included secure calls in which digital voice transmission was encrypted. This technique would be important to user agencies participating in the U.S. National Communications System such as the FBI and the Drug Enforcement Agency, Rafferty said.

JPL's role is strictly to develop new technologies required for a mobile satellite system. NASA plans to seek cooperative agreements with the commercial operator of a first-generation satellite system whereby the space agency would launch the first satellite. In exchange, NASA would be able to conduct technology validation experiments using a small percentage of the satellite's capacity.

Now that a prototype system has been demonstrated, Rafferty said, MSAT-X work at JPL will shift to more "applications-oriented" issues.

MSAT-X is funded by the Headquarters Communications and Information Systems Division of NASA's Office of Space Science and Applications, Washington, D.C.

- end -

NASA News

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For Release:
September 14, 1989

Jim Ball
Headquarters, Washington, D.C.
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RELEASE: 89-142

STUDY IDENTIFIES ECONOMIC BENEFITS FROM NASA TECHNOLOGY SPINOFFS

A study examining in detail some 250 commercial uses of NASA-furnished technology has identified estimated economic benefits totalling nearly $22 billion in sales revenues and cost savings and an employment impact of more than 350,000 jobs.

The study, entitled An Exploration of Benefits From NASA "Spinoff," was conducted for NASA by the Chapman Research Group, Inc., under contract to NERAC, Inc., a NASA Industrial Application Center located in Tolland, Conn.

More than 400 companies were contacted to research the economic benefits derived from NASA-developed or provided technology in terms of sales revenues and cost savings, generation of jobs and contributions in federal corporate income taxes. NASA's annual Spinoffs report, first published in 1976, provided the source of the cases studied.

Based on discussions with the firms that used the NASA technology, researchers identified 259 cases where the contribution of the technology to sales or cost savings was quantifiable. In these cases, the technology spinoff resulted in or contributed to sales of $21.3 billion and realized savings of more than $315 million. These commercial applications also produced an estimated $356 million in federal corporate income taxes.

The cases, all reported between 1978 and 1986, studied in this research represent only a small portion of the thousands of applications of NASA technology. A follow-on study, currently in process, will attempt to estimate the full impact of the estimated 20,000 to 30,000 NASA technology applications.

Copies of the report may be obtained by writing the NASA Scientific and Technical Information Facility, P.O. Box 8757, Baltimore, Md., 21240.

-end-

NOTE TO EDITORS: Copies of the report are available in the NASA Headquarters newsroom for news media representatives.

NASA News

National Aeronautics and
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For Release:
September 14, 1989

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Jeffrey Carr
Johnson Space Center, Houston
(Phone: 713/483-5111)

RELEASE: 89-143

FIRST GROUP OF PROSPECTIVE ASTRONAUTS TO ARRIVE AT JSC

The first of several groups of prospective astronauts will arrive at the Johnson Space Center, Houston, on Monday, September 18, to begin a week of orientation, interviews and medical evaluations.

Approximately 100 of the nearly 2500 total applicants are expected to be interviewed here over the next several weeks for an opportunity to be among the final 15 to 20 who will be named as astronaut candidates in January 1990.

The first group of 20 will consist of Paul J. Bertsch, Johnson Space Center, Houston; Jay C. Buckey, M.D., Dallas, Texas; Leroy Chiao, Ph.D., Danville, Calif.; Michael R. Clifford (Maj., USA), Seabrook, Texas; David B. Cripps (Maj., USA), Edwards, Calif.; Steven R. Hamel (Lcdr, USN), Ft. Washington, Md; Bernard A. Harris, Jr., M.D., Johnson Space Center; David E. Hollowell, Ph.D., Los Alamos, N.Mexico; James A. Jones (Lcdr, USN) Virginia Beach, Va.; Michael E. Lopez-Alegria (Lt.,USN), Waldorf, Md.; Ellen Ochoa, Ph.D., Ames Research Center, Mountain View, Calif.; Thomas P. Phelan (Lt., USN), Hollywood, Md.; Kent V. Rominger (Lt., USN), California, Md.; James C. Seat (Maj., USAF), Edwards, Calif.; Mark D. Shackelford (Maj., USAF), Edwards, Calif.; Richard A. Stevens (Maj. USAF), Edwards, Calif.; Keith A. Taylor, Sc.D., Copley, Pa.; Donald A. Thomas, Ph.D., Johnson Space Center; Carl E. Walz (Capt., USAF), Henderson, Nev.; and Dorothy J. Zukor, Ph.D., NASA Headquarters, Washington, D.C.

Astronaut selections are conducted on a bi-annual basis. The number of candidates selected every two years will vary based on flight rate, program requirements and attrition.

-end-

NASA News

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AC 202-453-8400

Terri Sindelar
Headquarters, Washington, D.C.
(Phone: 202/453-8400)

For Release:
September 15, 1989

RELEASE: 89-144

PLANETARY EXPLORATION FEATURED IN NEXT SATELLITE VIDEO CONFERENCE

On October 3, NASA's Educational Affairs Division, Washington, D.C., through Oklahoma State University, Stillwater, will transmit via satellite an educational, video conference to discuss upcoming solar system exploration missions and the recent Voyager encounter with Neptune.

Dr. Lennard A. Fisk, NASA's Associate Administrator of Space Science and Applications, will discuss NASA's upcoming space science and planetary missions. NASA has planned or already has underway over 35 major space science missions during the next 5 years. These include: the Magellan mission, launched from the Space Shuttle last May, will radar map Venus; the Galileo spacecraft, scheduled for launch Oct. 12, which will study Jupiter; the Cosmic Background Explorer, to be launched in early November, which will examine the sun's radiation; Hubble Space Telescope, a free-flying observatory to investigate celestial bodies and study the history and evolution of the universe, is scheduled for launch in March 1990. Dr. Fisk also will discuss NASA's plans for the Craf-Cassini missions to rendezvous with a comet and study Saturn and its moon Titan.

Dr. Edward C. Stone, Voyager Project Scientist, NASA Jet Propulsion Laboratory, Pasadena, Calif., will discuss the recent Voyager 2 encounter with Neptune and show imagery of the planet and its recently discovered massive dark spot, rings and moons.

These live, 1-1/2 hour, interactive, video conferences are designed to update teachers on NASA programs, demonstrate aerospace activities for the classroom and announce new programs, products and activities available to classroom teachers. The nation's participating school districts will receive transmissions from 2:30 to 4:00 p.m. Eastern time.

NASA's education satellite, video-conference series, now in its fourth year, have been highly praised by educators throughout the nation. This year more than 20,000 educators in 50 states are expected to participate.

- more -

The 1989-90 video conference schedule is:

Planetary Exploration - Oct. 3, 1989
Flight Testing - Dec. 5, 1989
Space Science in the Classroom (SEEDS) - Jan. 23, 1990
Robotics in Space - Mar. 27, 1990

The Oct. 3 conference will be transmitted on Westar IV, channel 19. There is no charge for registration or participation in the video conference.

To register for the series, interested teachers should write to NASA Aerospace Education Services Project, Videoconference Site, 300 North Cordell, Oklahoma State University, Stillwater, Okla., 74078-0422, or call 405/744-7015. Registration ensures that announcements, publications and other materials for teacher-participants are received at the school.

Media and organizations interested in participating can access the satellite or view the event from NASA Headquarters, 400 Maryland Ave., S.W., room 6004, Washington, D.C.

- end -

NASA News

National Aeronautics and
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For Release:

September 18, 1989

N89-64

ATLAS CENTAUR-68/FLTSATCOM PRELAUNCH NEWS CONFERENCE SET

The pre-launch news conference for Atlas Centaur-68, which will loft the FltSatCom F-8 communications satellite into orbit for the U.S. Navy, has been scheduled for 2 p.m. EDT on Wednesday, September 20, at Kennedy Space Center, Fla. Participating in the briefing will be:

James L. Womack, Director, Expendable Vehicles, NASA Kennedy Space Center

John W. Gibb, Launch Vehicle Project Manager, NASA Lewis Research Center, Cleveland

Frank E. Watkins, Director, Base Operations, General Dynamics Space Systems, Cape Canaveral Air Force Station, Fla.

Commander James O. Hall, Deputy, FltSatCom Project, U.S. Navy

The briefing will be carried by NASA Select television on Satcom F2-R, transponder 13. Audio-only also will be available on the V-2 circuits, which may be dialed directly at 407/867-1220, -1240 and -1260.

News Media representatives wishing to attend the briefing should be at the KSC News Center by 1:15 p.m. for transportation to the E&O building on Cape Canaveral Air Force Station. Those needing accreditation should call the KSC News Center at 407/867-2468 before 4:30 p.m., Tuesday, Sept. 19, to arrange for badging.

REMOTE CAMERA SET-UP FOR LAUNCH

On Thursday, September 21, photographers may install remote cameras at Launch Complex 36. Transportation to the pad will leave the KSC News Center at 4 p.m. EDT.

- more -

LAUNCH DAY:

On Friday, September 22, the launch window for AC-68 and FltSatCom F-8 extends from 4:15 a.m. to 4:45 a.m. EDT. Media representatives may obtain badging at the Gate 1 Pass and Identification Building on Cape Canaveral Air Force Station from 2:45 a.m. until 3:15 a.m. All media then will be escorted to Press Site 1 on Cape Canaveral Air Force Station. NASA Select and V-2 coverage of the launch will begin at 3 a.m.

- end -

NASA News

National Aeronautics and
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(Phone: 213/643-0254)

Jack Isabel
General Dynamics, San Diego, Calif.
(Phone: 619/547-9000)

For Release:

September 18, 1989

RELEASE: 89-145

NASA TO LAUNCH NAVY COMMUNICATIONS SATELLITE

Agency officials today announced a target date of no earlier than September 22 for the 68th and final launch of a NASA Atlas/Centaur vehicle. Atlas/Centaur-68 is scheduled to place the last in a series of Navy FLTSATCOM communications spacecraft into a geosynchronous Earth orbit. Launch will take place from Complex 36B, Cape Canaveral Air Force Station, Fla. The 30-minute launch window opens at 4:15 a.m., EDT.

This final chapter in NASA's Atlas/Centaur history has roots dating back to May 1962, when the first launch took place. Since then, the program has earned its place in history with missions such as Ranger and Surveyor probes to the Moon; Mariner flights to Mars, Venus and Mercury; and several series of communications satellite launches including FLTSATCOM, Intelsat and Comstar.

FLTSATCOM satellites -- five have been sucessfully placed into orbit -- are the spaceborne portion of a worldwide Navy, Air Force and Department of Defense system to enable communications between naval aircraft, ships, submarines, ground stations, Strategic Air Command elements and Presidential Command Network.

- more -

The FLTSATCOM program is managed by the Space and Naval Warfare Systems Command. The Air Force Space Systems Division, Los Angeles, is responsible for production, launch vehicle/spacecraft integration and tracking and data acquisition. FLTSATCOM spacecraft are built in Redondo Beach, Calif., by the Defense and Space Systems Group of TRW, Inc.

Atlas/Centaur is built for NASA by General Dynamics Space Systems Division, San Diego, Calif. General Dynamics, under an agreement signed with NASA in 1988, has assumed operation and control of Launch Complex 36 and in the future, will provide commercial Atlas launch transportation services for both the Government and the private sector from that site. With NASA oversight, General Dynamics will serve in the capacity of Launch Director for the upcoming mission.

- end -

NOTE TO EDITORS

Events and logistics associated with the upcoming launch of Atlas/Centaur-68 follow:

NEWS CONFERENCES: An L-2 day prelaunch conference is presently scheduled for 2 p.m., EDT, on Wednesday, September 20. The conference will be held in the E&O Building Conference Room, Cape Canaveral Air Force Station (CCAFS). If sufficient on-site press interest exists, a postlaunch conference also may be held at the same location at approximately T+1 hour. Conference participants will include NASA, DoD and General Dynamics program officials. Local press questions only will be accommodated.

PRESS VIEWING: Press viewing of the launch will be from Press Site 1, CCAFS.

ACCREDITATION AND BADGING: Requests for accreditation and badging for the launch should be directed to the Kennedy Space Center Public Information Branch, Phone: 407/867-2468. Special audio-visual requirements (remote camera setups will be accommodated) should be directed to the KSC audio visual office, Phone: 407/867-7819.

NASA SELECT COVERAGE: Audio and video of the prelaunch and postlaunch (if held) news conferences will be carried via NASA SELECT television. Launch commentary and video also will be carried via NASA SELECT beginning at 3 a.m. EDT, launch morning. NASA Select is available via GE Satcom F2R, Transponder 13, 72 degrees W. Longitude, 3960 MHz, vertical polarization.

- end -

PRESS KIT

ATLAS/CENTAUR-68, FLTSATCOM F-8 LAUNCH

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For Release:

September 18, 1989

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Agency officials today announced a target date of no earlier than September 22 for the 68th and final launch of a NASA Atlas/Centaur vehicle. Atlas/Centaur-68 is scheduled to place the last in a series of Navy FLTSATCOM communications spacecraft into a geosynchronous Earth orbit. Launch will take place from Complex 36B, Cape Canaveral Air Force Station, Fla. The 30-minute launch window opens at 4:15 a.m., EDT.

This final chapter in NASA's Atlas/Centaur history has roots dating back to May 1962, when the first launch took place. Since then, the program has earned its place in history with missions such as Ranger and Surveyor probes to the Moon; Mariner flights to Mars, Venus and Mercury; and several series of communications satellite launches including FLTSATCOM, Intelsat and Comstar.

FLTSATCOM satellites -- five have been sucessfully placed into orbit -- are the spaceborne portion of a worldwide Navy, Air Force and Department of Defense system to enable communications between naval aircraft, ships, submarines, ground stations, Strategic Air Command elements and Presidential Command Network.

- more -

The FLTSATCOM program is managed by the Space and Naval Warfare Systems Command. The Air Force Space Systems Division, Los Angeles, is responsible for production, launch vehicle/spacecraft integration and tracking and data acquisition. FLTSATCOM spacecraft are built in Redondo Beach, Calif., by the Defense and Space Systems Group of TRW, Inc.

Atlas/Centaur is built for NASA by General Dynamics Space Systems Division, San Diego, Calif. General Dynamics, under an agreement signed with NASA in 1988, has assumed operation and control of Launch Complex 36 and in the future, will provide commercial Atlas launch transportation services for both the Government and the private sector from that site. With NASA oversight, General Dynamics will serve in the capacity of Launch Director for the upcoming mission.

- end -

NOTE TO EDITORS

Events and logistics associated with the upcoming launch of Atlas/Centaur-68 follow:

NEWS CONFERENCES: An L-2 day prelaunch conference is presently scheduled for 2 p.m., EDT, on Wednesday, September 20. The conference will be held in the E&O Building Conference Room, Cape Canaveral Air Force Station (CCAFS). If sufficient on-site press interest exists, a postlaunch conference also may be held at the same location at approximately T+1 hour. Conference participants will include NASA, DoD and General Dynamics program officials. Local press questions only will be accommodated.

PRESS VIEWING: Press viewing of the launch will be from Press Site 1, CCAFS.

ACCREDITATION AND BADGING: Requests for accreditation and badging for the launch should be directed to the Kennedy Space Center Public Information Branch, Phone: 407/867-2468. Special audio-visual requirements (remote camera setups will be accommodated) should be directed to the KSC audio visual office, Phone: 407/867-7819.

NASA SELECT COVERAGE: Audio and video of the prelaunch and postlaunch (if held) news conferences will be carried via NASA SELECT television. Launch commentary and video also will be carried via NASA SELECT beginning at 3 a.m. EDT, launch morning. NASA Select is available via GE Satcom F2R, Transponder 13, 72 degrees W. Longitude, 3960 MHz, vertical polarization.

- end -

ATLAS/CENTAUR LAUNCH VEHICLE

The Atlas/Centaur is NASA's standard launch vehicle for intermediate weight payloads. It is used to launch payloads into low-Earth orbit, geosynchronous-Earth orbit and on interplanetary trajectories.

Centaur was the nation's first high-energy, liquid hydrogen/liquid oxygen propelled rocket. Developed and launched under the direction of NASA's Lewis Research Center, Cleveland, it became operational in 1966 with the launch of Surveyor 1, the first U.S. spacecraft to soft-land on the lunar surface.

Since that time, both the Atlas booster and Centaur second stage have undergone many improvements. At present, the vehicle combination can place 13,500 pounds in low-Earth orbit, 5,100 pounds in a synchronous transfer orbit and 2,180 pounds on an interplanetary trajectory.

The Atlas/Centaur, approximately 137 feet high, consists of an Atlas SLV-3G booster and Centaur D-1AR second stage. The Atlas booster develops 438,922 pounds of thrust at liftoff using two 188,750 thrust booster engines, one 60,500 pound thrust sustainer engine and two vernier engines developing 461 pounds thrust each. The two RL-10 engines on Centaur produce a total of 33,000 pounds of thrust. Both the Atlas and Centaur are 10-feet in diameter.

Until early 1974, Centaur was used exclusively in combination with the Atlas booster. It was subsequently used with a Titan III booster to launch heavier payloads into Earth orbit and interplanetary trajectories.

The Atlas and the Centaur vehicles have been updated over the years. Thrust of the Atlas engines has been increased about 50,000 pounds since their first use in the space program in the early 1960's.

The Centaur D-1AR has an integrated electronic system that performs a major role in checking itself and other vehicle systems before launch and also maintains control of major events after liftoff. The new Centaur system handles navigation and guidance tasks, controls, pressurization and venting, propellant management, telemetry formats and transmission and initiates vehicle events. Most operational needs can be met by changing the computer software.

ATLAS/CENTAUR-68 LAUNCH VEHICLE CHARACTERISTICS

A/C-68 liftoff weight including spacecraft is 360,917 pounds. Liftoff height is 137 feet. Launch Complex 36 (Pad B) is used for the launch operation.

	ATLAS BOOSTER	CENTAUR STAGE
Fueled Weight	320,701 lbs.	38,824 lbs.
Height:	76 feet	61 feet with payload fairing
Thrust:	438,922 lbs at sea level	33,000 lbs in vacuum
Propellants:	Liquid oxygen and RP-1	Liquid oxygen/ liquid hydrogen
Propulsion:	MA-5 system two 188,750 lb thrust booster engines, one 60,500 lb thrust sustainer engine, two 461 lb thrust vernier engines	Two 16,500 pound thrust RL-10 engines, 12 small hydrazine thrusters
Velocity:	6,584 mph at booster engine cutoff (BECO), 9,486 mph at sustainer engine cutoff (SECO)	22,513 mph at spacecraft separation
Guidance:	Preprogrammed profile through BECO. Switch to inertial guidance for sustainer phase	Inertial guidance

FLEET SATELLITE COMMUNICATIONS SYSTEM

The Fleet Satellite Communications System, managed by the U.S. Navy, provides near global satellite communications for high priority requirements of the Navy, Air Force and other Department of Defense communications needs.

Five satellites presently comprise the FLTSATCOM constellation. Two satellites in the planned eight-satellite series were lost -- the Flight 4 spacecraft was damaged during launch in 1981 and did not operate and the Flight 6 spacecraft and launch vehicle were destroyed by an apparent lightning strike during launch in 1987.

Each FLTSATCOM spacecraft has 23 communications channels in the ultra-high and super-high frequency bands. Ten of the channels are used by the Navy for worldwide communications among its land, sea and air forces. Twelve of the channels are used by the Air Force as part of the Air Force Satellite Communications System for command and control nuclear capable forces. A 500 kilohertz channel on the satellite is allotted to National Command Authority.

The ground segment of the fleet satellite system consists of links among designated and mobile users, including most U.S. Navy ships and selected Air Force and Navy aircraft, submarines, global ground stations and presidential command networks. These terminals are being managed and acquired by the individual services.

FLTSATCOM FLIGHT-8 CHARACTERISTICS (A/C-68)

WEIGHT: The final FLTSATCOM spacecraft (designated Flight-8) along with its apogee kick motor, with solid propellant, weighs approximately 5,100 pounds going into transfer orbit.

SIZE: The Flight-8 spacecraft body is 8 feet in diameter and 22.8 feet high. Main parabolic antenna is 16 feet in diameter with an 80-inch solid center surrounded by a wire mesh screen. Once in orbit, the folded screen is deployed by ground command. A 13.5 foot helical receive antenna, 13-inches in diameter at the base, is mounted outside the edge of the transmit antenna dish. The receive antenna also is folded within the Centaur fairing during launch and deployed by separate ground commands.

POWER: Primary electrical power for the Flight-8 spacecraft is provided by two deployable solar array paddles which supply approximately 1,200 watts of power. In addition, three nickel-cadmium batteries, each having 24-sealed, 34-amp-hour cells, provide power during eclipse operations.

DESIGN LIFE: 5 years

ORBIT: The satellites are three-axis stabilized in geosynchronous orbit, 22,250 nautical miles above the Earth's equator.

MAJOR CONTRACTOR: TRW Space and Defense Systems Group, Redondo Beach, Calif.

ATLAS/CENTAUR-68 LAUNCH VEHICLE PREPARATIONS

Kennedy Space Center is responsible for pre-launch processing and testing of the Atlas Centaur-68 vehicle. Most of this activity occurred at Launch Complex 36 on the Cape Canaveral Air Force Station (CCAFS).

The launch of AC-68 originally was planned for 1987, but was postponed after a leak was discovered during a terminal countdown demonstration test in June of that year. The leak, near the Centaur number one engine gimbal assembly, resulted in a decision to demate the Centaur stage.

During the disassembly process, a workstand was dislodged, fell and struck the Centaur liquid hydrogen tank, causing the rupture and loss of the tank. An investigation board concluded that the tank was ruptured when a leg of the falling workstand penetrated the tank skin.

A new Centaur stage had to be fabricated and both the Atlas booster and Centaur upper stage were shipped back to the General Dynamics plant in San Diego.

The current Atlas/Centaur vehicle arrived by C5A transport plane at the Skid Strip on CCAFS on May 24. The Atlas first stage was erected in the gantry of Pad B on Launch Complex 36 on June 6 and the interstage adapter was attached the next day. The Centaur stage was hoisted into the gantry and mated to the Atlas stage on June 8. The vehicle was powered up for integrated testing on June 20.

A terminal countdown demonstration, which includes loading the vehicle with propellants, was conducted Aug. 22. This test served as a launch team certification and is designed to simulate as closely as possible all pre-liftoff events on launch day, including the loading of propellants.

A flight events demonstration, an electrical test which simulates post-liftoff events and exercises all components aboard the vehicle used during powered flight, was conducted on Sept. 7.

All launch vehicle and pad operations during the countdown are conducted from the blockhouse at Complex 36 by a joint NASA-General Dynamics Space Systems launch team.

FLTSATCOM F-8 SATELLITE PRELAUNCH PROCESSING

The FLTSATCOM F-8 spacecraft was shipped from the TRW plant in Redondo Beach, Calif., and arrived at Hangar AM on Cape Canaveral Air Force Station on July 31.

The satellite was removed from its environmentally controlled storage canister and testing was resumed. The systems tests were completed on Aug. 11.

The satellite was transported to the Explosive Safe Area (ESA-60) on Aug. 21. The apogee kick motor, the solid propellant rocket used to circularize the orbit at geosynchronous altitude, was installed on Aug. 21 and 22 at this facility.

Encapsulation of the spacecraft in the nose fairing, which protects the spacecraft during the portion of flight within the Earth's atmosphere, was accomplished on Sept. 11.

The satellite was scheduled to be transferred to Pad B at Launch Complex 36 on Sept. 12, where it was hoisted into position atop the Atlas Centaur rocket. A composite electrical readiness test was completed on Sept. 14, to demonstrate the operation of all airborne electrical systems and components used in-flight.

Spacecraft prelaunch processing, testing and launch vehicle integration are managed and conducted by a joint Air Force/TRW test team at CCAFS.

DOWNRANGE LAUNCH SUPPORT

Launch vehicle telemetry and data will be established through the NASA Spaceflight Tracking and Data Network and the Air Force Eastern Test Range. Initial launch coverage will come from the Merritt Island Launch Area station located at Kennedy Space Center and the USAF's Tel-4 station located on south KSC, followed by the NASA station on Bermuda. As the vehicle moves downrange, tracking support will be provided by other NASA stations at Ascension Island and Canberra, Australia.

The Eastern Test Range also will supply telemetry and data from its stations at Tel-4, Jupiter Inlet, Fla., and from its downrange tracking station on the island of Antigua. A pair of Advanced Range Instrumentation Aircraft stationed over the Atlantic Ocean between Ascension Island and Africa will cover the time interval of the second main engine burn on the Centaur stage and the subsequent spacecraft separation.

NASA and Department of Defense radars will provide downrange trajectory information to range safety personnel and computers. The radars are located at Cape Canaveral, Tel-4 Patrick Air Force Base, Jupiter Inlet, Bermuda and Antigua.

FLIGHT EVENTS SEQUENCE: ATLAS/CENTAUR-68, FLTSATCOM F-8

EVENT	TIME AFTER LIFTOFF	ALTITUDE (miles)	DISTANCE DOWNRANGE (miles)	SPEED (mph)
Liftoff	T-0	------	-------	-------
Atlas Booster Engine Cutoff	2 min 35 sec	37	55	5,703
Jettison Atlas Booster Engine	2 min 38 sec	39	60	5,704
Jettison Centaur Insulation Panels	3 min 0 sec	51	93	6,124
Jettison Nose Fairing	3 min 43 sec	71	169	7,055
Atlas Sustainer/ Vernier Engines Cutoff	4 min 30 sec	89	266	8,466
Atlas/Centaur Separation	4 min 32 sec	89	271	8,469
First Centaur Main Engines Start	4 min 43 sec	97	295	8,441
Centaur Main Engines Cutoff	9 min 55 sec	102	1,294	16,652
Second Centaur Main Engines Start	23 min 56 sec	101	5,013	16,686
Second Centaur Main Engines Cutoff	25 min 32 sec	110	5,600	22,013
Centaur/Payload Separation	27 min 47 sec	179	6,391	21,791

(These numbers may vary, depending on exact launch date, launch time and spacecraft weight)

GENERAL DYNAMICS/LAUNCH COMPLEX 36: A NEW ERA

General Dynamics, under an agreement signed with NASA in 1988, has assumed operation and control of Launch Complex 36, CCAFS. Following the upcoming Atlas/Centaur-68 mission, the company plans to provide commercial Atlas launch services from that site for both NASA and private customers.

General Dynamics' first commercial launch of its Atlas I vehicle is scheduled for 1990 with a launch rate capability of four launches per year from Complex 36B. The Atlas I configuration accommodates an 11-foot-diameter as well as a 14-foot-diameter fairing enabling the vehicle to perform a broader range of missions. General Dynamics also is developing a commercial derivative of its military Atlas II vehicle. The commercial configuration is called Atlas IIA, which will offer 25 percent higher performance than Atlas I. Atlas II class vehicles begin launch operations in 1992.

To date, General Dynamics has contracted for commercial launch services with four users. A EUTELSAT II spacecraft is scheduled for a 1990 launch with options for two additional launches. NASA, on behalf of the National Oceanic and Atmospheric Administration, has contracted for commercial launch services for up to five Geostationary Operational Environmental Satellites (GOES). The first GOES launch is scheduled for 1990. In addition, NASA has awarded the 1990 launch of its Combined Release and Radiation Effects Satellite to General Dynamics for a commercial Atlas launch.

General Dynamics also is under contract from Hughes to launch 10 of the new generation UHF Follow-On communications satellites, and Intelsat has contracted for two launches on Atlas IIAs.

- more -

PREVIOUS ATLAS CENTAUR VEHICLE FLIGHTS

PROGRAM INITIATION DATE: 1958   FIRST FLIGHT: May 8, 1962
LAUNCHES TO DATE: 67   LAUNCH VEHICLE SUCCESSES: 57

LAST 20 FLIGHTS

LAUNCH DATE	LAUNCH VEHICLE	SPACECRAFT	FINAL PAYLOAD ORBIT ACHIEVED	S/F*
AUG 8,1978	AC-51	PIONEER VENUS-2	HELIO	S
NOV 13,1978	AC-52	HEAO B	LEO	S
MAY 4, 1979	AC-47	FLTSATCOM-2	GSO	S
SEP 20, 1979	AC-53	HEAO 3	LEO	S
JAN 17, 1980	AC-49	FLTSATCOM-3	GSO	S
OCT 30, 1980	AC-57	FLTSATCOM-4	GSO	S
DEC 6, 1980	AC-54	INTELSAT V	GSO	S
FEB 21, 1981	AC-42	COMSTAR D-4	GSO	S
MAY 23, 1981	AC-56	INTELSAT V	GSO	S
AUG 6, 1981	AC-59	FLTSATCOM-5	GSO	F
DEC 15, 1981	AC-55	INTELSAT V	GSO	S
MAR 4, 1982	AC-58	INTELSAT V	GSO	S
SEP 28, 1982	AC-60	INTELSAT V	GSO	S
MAY 19, 1983	AC-61	INTELSAT V	GSO	S
JUN 9, 1984	AC-62	INTELSAT V		F
MAR 22, 1985	AC-63	INTELSAT VA	GSO	S
JUN 29, 1985	AC-64	INTELSAT VA	GSO	S
SEP 28, 1985	AC-65	INTELSAT VA	GSO	S
DEC 4, 1986	AC-66	FLTSATCOM-7	GSO	S
MAR 26, 1987	AC-67	FLTSATCOM-6		F

(S/Successful   F/Failure)*

ATLAS/CENTAUR-68, FLTSATCOM F-8 LAUNCH TEAM

NASA Headquarters	
J.B. Mahon	Deputy Associate Administrator for Space Flight (Flight Systems)
C.R. Gunn	Director of Unmanned Launch Vehicles and Upper Stages
J.P. Castellano	Chief, Intermediate and Large Launch Vehicles
Kennedy Space Center	
Gen. F.S. McCartney	Director
John T. Conway	Director, Payload Management and Operations
James L. Womack	Director, Expendable Vehicle Operations
James E. Weir	Chief, Payload Support Management Branch
S. M. Francois	Chief, Launch Operations Division
David C. Bragdon	Spacecraft Coordinator
Lewis Research Center	
Dr. J.M. Klineberg	Director
V.J. Weyers	Director of Space Flight System
S.V. Szabo	Director of Engineering
J.W. Gibb	Manager, Launch Vehicle Project Office
R.E. Orzechowski	FLTSATCOM Mission Manager
E. Procasky	A/C-68 Chief Engineer
FLTSATCOM	
Col. S.P. Purdy	FLTSATCOM Program Director
Cmdr. J.O. Hall	Asst. Dep. Director for FLTSATCOM
Capt. B.J. Sapp	FLTSATCOM Program Manager
Capt. T.R. Newman	FLTSATCOM Launch Operations Manager
General Dynamics	
D.R. Dunbar	GDCLS/Atlas/Centaur Vice President and Technical Director
B.J. Sherwood	GDCLS/Program Manager FLTSATCOM
F.E. Watkins	GDSS-CCAFS Director Base Operations
S.K. Baker	GDSS-CCAFS Engr. Managerm Atlas I/II Launch Operations
R.J. Moberly	GDSS/Atlas/Centaur Program Manager
W.F. Sauer	GDSS/A/C-68 Chief Engineer
TRW	
B. Beckham	Program Manager FLTSATCOM
F. Wohrman	Launch Operations Director

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202-453-8400

Terri Sindelar
Headquarters, Washington, D.C.
(Phone: 202/453-8400)

For Release:
September 18, 1989

RELEASE: 89-146

NATIONAL STUDENT WINNERS NAMED IN SPACE SCIENCE COMPETITION

NASA and the National Science Teachers Association held the 9th annual Space Science Student Involvement Program (SSIP) competition in Washington, D.C., the week of Sept. 14-16. National SSIP winners were selected in three competition categories: Space Station Freedom experiment proposal, school newspaper promotion, and Destination Mars team competition.

In the Space Station Freedom experiment proposal competition, eight national winners presented proposals to the selection panel on Sept. 14. Selected from over 1,600 proposals, the following are the three national scholarship recipients, their proposals and awards:

First Place: Diane M. Fogel, Landsdale, Pa. Topic: "The Effects of Calcitonin in Establishing Calcium Homeostasis in Microgravity." The proposal examines the effects of the hormone calcitonin and Vitamin D in reducing bone loss in microgravity. Fogel was awarded a $3,000 scholarship and a Tandy computer.

Second Place: Bianca Santomasso, New York City. Topic: "Determing the Effect of Microgravity on Circulation to the Hands and Feet in Humans through the Measurement of Nail Growth." Her proposal states that because circulation to the hands and feet has been shown to have an effect on nail growth, measuring this growth in microgravity would help determine whether weightlessness has some effect on circulation to these areas. She was awarded a $2,000 scholarship and a Tandy computer.

Third Place: Mark G. Baxter, Durham, N.C. Topic: "Effect of Microgravity on the Membrane Transport System of Chorella." This research, on the ion absorption rate in the active transport system of algae, could shed light on the ability to grow hydroponic plants in space as a potential food source and as a water purification system. Baxter won a $1,000 scholarship and a Tandy computer.

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The other five national winners each received an eight-volume set of the World Book Encyclopedia of Science. Those winners are: Rebecca Glasser, West Allis, Wisc.; Antonio Algaze-Beato, San Juan, P.R.; Ronnie E. Raney, Lenexa, Kan.; Sabry G. Mansour, Los Angeles, Calif.; and Amy E. Ksir, Laramie, Wyo.

The selection panelists for the Space Station proposals were Dr. John-David Bartoe, Chief Scientist, Office of Space Station, NASA Headquarters; Dr. Ruth Ann Lewis, Satellite Servicing Tool Development Manager, NASA Goddard Space Flight Center, Greenbelt, Md.; Dr. David Almgren, President, Q-metrics, Inc., Cambridge, Mass.; and Ms. Elizabeth Waring, Director, Mathematics and Science Center, Richmond, Va.

In addition to the Space Station Freedom experiment proposal winners, two national student newspaper competition winner were honored during the symposium.

The national student newspaper award winners are Allen Chen, Columbus, Ind., for a news feature and Paul Michael Schumacher, Yuma, Ariz., for an advertisement. They were each awarded a $250 scholarship from Gannett Co., Inc.

A team of three Mechanicsburg, Pa., students was acknowledged for winning a SSIP pilot project involving a statewide competition to design and plan the first permanent manned colony on Mars. This is the fourth year of the pilot competition in the states of Pennsylvania, Wisconsin and Texas. The "Destination Mars" team proposal consisted of three parts: societal elements (international cooperation, financing, crew composition), engineering plan (habitat structure, human support systems, power sources, waste and water management) and scientific purpose and results (human effects and environmental research). The students from Mechanicsburg Area High School are Eric Bauer, Andrew Thoma and Roger Baker and the teacher/advisor is William Murray.

Since NASA resumed Space Shuttle flights in September 1988, four student experiments have flown on the Shuttle. To date, 19 SSIP experiments have flown aboard the Shuttle. An SSIP experiment proposed by Tracy Peters, Walnut Creek, Calif., is slated for Shuttle mission 34, planned for launch on Oct. 12, 1989.

The objective of the SSIP competition is to stimulate interest in science and technology by directly involving students in a space or aeronautics research program. Since 1980, approximately 2.5 million students have used the space science program materials in classrooms and over 15,000 students have submitted proposals. The Space Science Student Foundation and private donors provide the awards annually.

Entry materials for the 1989-90 SSIP program may be obtained by writing to the National Science Teachers Association, 5112 Berwyn Road, Third Floor, College Park, Md. 20740.

- end -

NASA News

National Aeronautics and
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Washington, D.C. 20546
AC 202-453-8400

For Release:

Sarah Keegan
Headquarters, Washington, DC
(Phone: 202/453-8536)

September 18, 1989
7:00 p.m. EDT

NASA ADVISORY - STS-34/HURRICANE HUGO

NASA management officials today decided to take the preliminary steps which would be required if a decision is made to move Orbiter Atlantis from the launch pad at the Kennedy Space Center (KSC), Fla., back to the vehicle assembly building (VAB) to protect it if Hurricane Hugo continues on its present course. A final decision to roll back or not will be made after weather briefings tomorrow.

In addition officials are proceeding with preparations to remove the FltSatCom from the Atlas Centaur on the pad at launch complex 36 at Cape Canaveral Air Force Station (CCAFS) so that this system also can be prepared for possible effects of the storm. A final decision will be made on this issue as well tomorrow.

At this point there is no firm assessment of what affect an Atlantis rollback would have on the date for launch of STS-34 or subsequent.

- end -

NASA News

National Aeronautics and
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Washington, D.C. 20546
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For Release:

Sarah Keegan
Headquarters, Washington, DC
(Phone: 202/453-8536)

September 19, 1989
8:30 a.m. EDT

NASA ADVISORY - STS-34/HURRICANE HUGO UPDATE

The overnight progress of Hugo and most recent weather forecasts appear to indicate a slightly more favorable situation with regard to the storm's track relative to KSC. NASA managers will continue to monitor the updated information issued periodically by the National Hurricane Center and, barring unforeseen developments, will assess the overall situation tomorrow morning.

NASA News

National Aeronautics and
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Washington, D.C. 20546
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For Release:
September 20, 1989
9:00 a.m. EDT

Sarah Keegan
Headquarters, Washington, DC
(Phone: 202/453-8536)

NASA ADVISORY - STS-34/HURRICANE HUGO UPDATE

Shuttle program managers have decided to proceed with work at the Kennedy Space Center in preparation for launch of STS-34. Most recent forecasts of Hugo's track relative to KSC seem to be increasingly favorable; however, officials will continue to monitor updated weather predictions every six hours or so until the storm no longer poses a threat.

\- end -

NASA News

National Aeronautics and
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Washington, D.C. 20546
AC 202-453-8400

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George H. Diller
Kennedy Space Center, Fla.
(Phone: 407/867-2468)

For Release:
September 20, 1989

N89-66

NOTE TO EDITORS: UPDATE ON ATLAS CENTAUR-68/FLTSATCOM LAUNCH

NASA has decided to resume launch preparations for the FltSatCom Navy communications satellite. The Atlas Centaur rocket, AC-68, is now scheduled to lift off from Launch Complex 36 on Monday, Sept. 25, at the opening of a launch window that extends from 4:12 a.m. to 4:42 a.m. EDT.

Air Force and National Hurricane Center weather forecasters have provided a cautiously optimistic forecast about the effects of Hurricane Hugo on the Cape Canaveral area. Plans are in place to cease launch preparations and take appropriate precautions should the weather picture change.

The pre-launch news conference for AC-68 is scheduled for 11:30 a.m. EDT on Friday, Sept. 22. The briefing will be carried by NASA Select television on Satcom F2-R, transponder 13. Audio only is also available on the V-2 circuits, which may be dialed directly at 407/867-1220, -1240 or -1260.

News media representatives wishing to attend the briefing should be at the KSC News Center by 10:45 a.m. for transportation to the E&O building on Cape Canaveral Air Force Station. Those needing accreditation should call the KSC News Center at 407/867-2468 to arrange for badging.

Remote camera set-up for launch will be on Sunday, Sept. 24. Transportation to the pad will leave the KSC News Center at 4 p.m. EDT.

On launch day, media representatives covering the launch may obtain badging at the Gate 1 Pass and Identification Building on Cape Canaveral Air Force Station from 2:45 a.m. until 3:15 a.m. EDT. All media then will be escorted to Press Site 1 on Cape Canaveral Air Force Station.

- end -

NASA News

National Aeronautics and
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Washington, D.C. 20546
AC 202-453-8400

Sarah Keegan
Headquarters, Washington, D.C.
(Phone: 202/453-8536)

For Release:
September 21, 1989
7:30 a.m. EDT

NASA ADVISORY: STS-34/Hurricane Hugo Update

Shuttle program managers have concluded that there is no credible scenario relative to hurricane Hugo which would require a rollback of Atlantis to the Vehicle Assembly Building at Kennedy Space Center, Fla., and therefore, have decided that the vehicle should remain on the launch pad.

For about the next 12 hours, KSC personnel will be preparing to resume work readying Atlantis for launch. During this time, officials will continue monitoring the weather to determine if the pad area might see winds of a velocity which would require a "ride out" configuration, although this is not forecast. This period also will provide an opportunity for rest for the KSC work crews.

- end -

NASA News

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Washington, D.C. 20546
AC 202-453-8400

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September 22, 1989

RELEASE: 89-147

JERRY J. FITTS APPOINTED DEPUTY ASSOCIATE ADMINISTRATOR OF OSO

NASA Administrator Richard H. Truly today announced the appointment of Jerry J. Fitts as the Deputy Associate Administrator for Space Operations, effective Oct. 8, 1989.

Fitts will succeed Charles T. Force, who was appointed the Associate Administrator for Space Operations in July 1989. The Office of Space Operations manages the agency's worldwide data and tracking network, which tracks and communicates with all manned and unmanned spacecraft and interplanetary probes.

Fitts received a Mechanical Engineering degree from the University of Utah in 1958, followed by a master's of science degree from Rensselear Polytechnic Institute.

Fitts' first engineering position was with Pratt and Whitney Aircraft working on propulsion systems development. He then accepted an opportunity with General Dynamics to participate in NASA's Centaur Program, the nation's first liquid hydrogen/oxygen rocket. In 1962, Fitts joined NASA's Space Nuclear Propulsion Office, where he ultimately became responsible for engine systems design and development at the Lewis Research Center. Fitts left NASA to help establish the Office of Research and Technology at the Department of Housing and Urban Development. He was Director of the Housing and Economic Research Division for 6 years.

In 1980, Fitts returned to NASA as the Deputy Director of the Space Shuttle Main Engines Program within the Headquarters Office of Space Flight (OSF). Subsequently, Fitts served in OSF as Director, Solid Rocket Booster and External Tank Division, and as Deputy Director, Customer Services Division.

- more -

In February 1987, Fitts became the Director of the Transportation Services Office, a focal point for the NASA, DOD, civil and international payload communities that require transportation services on the Space Shuttle or expendable launch vehicles. He also was responsible for space transportations policy development and manifesting of payloads on the various launch vehicle systems.

Fitts and his wife, Hartley Campbell Fitts, reside in McLean, Va. They have three children -- Stanford, Stewart and Jane Anne -- and two grandchildren.

- end -

NASA News

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John M. Dumoulin
Marshall Space Flight Center, Huntsville, Ala.
(Phone: 205/544-0034)

For Release:

September 25, 1989

RELEASE: 89-148

NASA OPENS ITS DATA BASES TO STIMULATE STUDENT SCIENCE/ENGINEERING

NASA has opened its computerized science data bases to the nation's universities to stimulate "cottage industry" space research by professors and entice more students to specialize in science and engineering studies.

Through the new Joint Venture (JOVE) Program, currently in the pilot phase at NASA's Marshall Space Flight Center (MSFC), Huntsville, Ala., NASA makes available scientific and engineering data generated from space missions in exchange for analysis and interpretation by faculty members and students. In 1989, NASA is expected to generate several trillion bits of raw science and engineering data -- roughly equal to the amount of information stored in the Library of Congress. Analyzing and translating the data into useful knowledge presents NASA with a big challenge and offers an unprecendented opportunity.

In addition to direct analysis of space science data, participating JOVE universities assume the role of space program emissaries, using the excitement of space to enhance educational programs in their areas of influence.

Currently in the first year, plans are to add seven more colleges and universities to the pilot phase in 1990. It is anticipated that in 1992 the JOVE program will enter an operational stage, subject to available funding and will allow broad college/university participation.

The JOVE program just completed the first summer of the pilot phase and the university response has been tremendous. The seven participating universities are so enthusiastic about the program that in some cases they are providing $3 to every $1 NASA has offered.

- more -

"Where NASA offered to pay the equivalent of one professor's salary this summer to do research, our university paid for three additional professors' salaries," said Dr. Gary White, JOVE faculty research associate from Northwestern State University, Natchitoches, La. "I've proposed to change the title of our physics curriculum to Space Physics. Because of JOVE, our program will have the substance to offer new courses with space science emphasis and offer the kinds of scholastic incentives to attract new students." White spent this past summer on a JOVE research project in solar science.

"Space provides the hook," said Dr. Rick Chappell, Associate Director for Science at MSFC and initiator of the JOVE idea. "Youngsters are interested in space. Space Science is a natural extension of that interest and can draw students from all backgrounds into the technical fields."

"JOVE is already helping train undergraduates in space astronomy at the University of Georgia," said Dr. J. Scott Shaw, Associate Professor of Astronomy. "The university has funded two undergraduate stipends this year for astronomy research as a direct result of JOVE, and we hope to sponsor four physics majors from other, smaller Georgia universities in 10 weeks of research next summer. Eventually the University of Georgia hopes to expand the program to 8 yearly, co-sponsored undergraduate stipends.

"For the first time," said Shaw, "we'll be able to regularly expose our students to the thrill of original space research." This research will include data from the International Ultraviolet Explorer and Einstein orbiting observatories. Universities also will assist NASA in the studies of the Earth's environment, planetary science and microgravity research, eventually including the orbiting sensors on satellites in NASA's Mission to Planet Earth program and on Space Station Freedom, according to Chappell.

This summer, Vanderbilt University, Nashville, Tenn., and Northwestern State sent professors to MSFC to participate in materials processing research. West Virginia University, Morgantown, and Northwestern State each sent professors to perform research in atmospheric science.

"This summer," said Chappell, "every research team discovered that the visiting professor brought a refreshing perspective to the research. They were a valuable resource and the program has been very successful for both research and educational outreach."

Texas Southern College, Houston, sent one of its faculty to work on a solar wind study at Rice University, Houston. Rice participates in JOVE as a research-sponsoring institution, having extensive experience in space science research.

"Educational outreach is one of the most exciting parts of JOVE," said Dr. Joe Perez, Department of Physics Chairman, Auburn University, Ala., who with three other Auburn physics professors spent part of the summer analyzing space physics data at MSFC. "We've received a good response across the state from elementary schools through 4-year colleges who want to participate. We hope to provide written and video materials to them, using space examples to teach basic physics principles. We've also sent a proposal to the National Science Foundation for a high school program for Alabama juniors and seniors to spend 2 weeks of space science research with one of our four JOVE professors."

"We plan to offer to high schools in Louisiana a space science course using a two-way satellite television system," said Dr. Bobby Alost, president of Northwestern State University, "and we've already received a grant from the Department of Education to set it up. We're also planning to initiate a pre-college 'Space Camp' in collaboration with Space Camp in Huntsville."

Texas Southern University expects to use the JOVE program to add a space component to an existing outreach program in predominantly Hispanic schools and to establish a space science lecture series at Houston-area high schools.

"The research side of the JOVE program -- the direct analysis of space science data -- is important, but in the long run it may be the contributions of the outreach portion, which involves generating science interests in pre-college students, that will bring the most far-reaching benefits," according to Chappell. "JOVE is showing that an involvement in the space program by universities is very positive for promoting careers in science.

"The future of the United States, particularly our economy, depends on our technology," said Chappell. "It's the kids who are now making career choices about science and engineering who are going to generate the new technology for the nation's future. They'll be our new explorers in science and technology.

"There are 250 U.S. universities now participating in some area of the space program," Chappell said. "By making NASA's world-class data available to institutions of higher education, JOVE could conceivably double that number in 5 to 10 years. Add to that the educational outreach programs, and you begin to understand the incredible impact of the JOVE program. Everybody wins -- scientists, educators, students and the nation!"

- end -

NOTE TO EDITORS: A 2-minute video clip supporting this press release is available from NASA by calling 202/453-8594.

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202-453-8400

Paula Cleggett-Haleim
Headquarters, Washington, D.C.
(Phone: 202/453-1548)

For Release:
September 25, 1989

Peter W. Waller
Ames Research Center, Mountain View, Calif.
(Phone: 415/694-5091)

N89-67: GALILEO PROBE MEDIA BRIEFING SET

The role of the Galileo spacecraft's probe, during the planet Jupiter exploration mission, will be detailed at a media briefing to be held at NASA's Ames Research Center, Mountain View, Calif., at 1 p.m. EDT, Thurs., Sept. 28.

The Galileo spacecraft, with the probe, will be launched from the Space Shuttle Atlantis no earlier than Oct. 12. Approaching Jupiter, the probe will be released to penetrate down 400 miles into Jupiter's atmosphere to make the first direct atmosphere measurements, seeking lightning, dense water clouds and clues to Jupiter's hurricane winds. Data gathered could disclose much more about the outer giant-gas planets and the origin of the solar system and the universe.

Reporters planning to attend the briefing should come to the Ames Pass and ID Office. Print and still photo material and two TV clips, with new mission animation, will be available. News organizations can downlink the briefing from NASA Select television, Satcom F2R, transponder 13, 72 degrees West longitude. Two-way question and answer capability will be available from NASA Headquarters, Wash., D.C., and most NASA field centers.

- end -

NASA News

National Aeronautics and
Space Administration

John F. Kennedy Space Center
Kennedy Space Center, Florida 32899
AC 407 867-2468

For Release

Jim Cast
NASA Headquarters
202/453-8536

George Diller
Kennedy Space Center
407/867-2468

Sept. 25, 1989

JOINT GOVERNMENT/INDUSTRY TEAM LAUNCHES ATLAS CENTAUR 68

A NASA/General Dynamics launch team and the AC-68 Atlas Centaur rocket have successfully placed the Navy's FltSatCom F-8 communications satellite into geosynchronous transfer orbit. Liftoff from Launch Complex 36 on Cape Canaveral came at 4:56:02 a.m. EDT this morning. All launch vehicle performance parameters were nominal, and the orbit of the satellite was described by project officials as "on the dime."

The AC-68 vehicle was the last in the NASA inventory of Atlas Centaur rockets, and the launch countdown procedure was the blueprint for commercial operation of the program by General Dynamics Space Systems.

The FltSatCom spacecraft, which is manufactured by TRW, is scheduled to fire its apogee kick motor early Tuesday evening. This will be followed on Wednesday morning by the solar panel and antenna deployments.

The next Atlas Centaur, which will be launched by General Dynamics, is scheduled for the summer of 1990. The payload is a joint NASA/U.S. Air Force program, the Combined Release and Radiation Effects Satellite (CRRES).

The next and last launch of a NASA expendable vehicle is the Cosmic Background Explorer (COBE) aboard a Delta rocket from Vandenberg Air Force Base in California. Launch is targeted for the morning of November 9.

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September 26, 1989
National Aeronautics and Space Administration
Small Business Innovation Research (SBIR) Proposals
Selected for Negotiation of SBIR Phase I Contracts
Sorted by State, Zipcode and Firm name

ALABAMA

MICROGRAVITY SYSTEMS INC
4215 AL 72E
BROWNSBORO, AL 35741
15.01-2043 (MSFC)
BILLY R. ALDRICH: 205-776-2043
PERMANENT MAGNET FLIGHT FURNACE

JOHN M. COCKERHAM & ASSOCIATES INC
301 RANDOLPH AVENUE SE
HUNTSVILLE, AL 35801
04.08-6381 (MSFC)
JACK E. SIMON: 205-536-6381
PORTABLE SPECTROREFLECTOMETER

ENGINEERING ANALYSIS INC
715 ARCADIA CIRCLE
HUNTSVILLE, AL 35801-5909
02.09-9391 (MSFC)
FRANK B. TATOM: 205-533-9391
THE APPLICATIONS OF FRACTIONAL CALCULUS TO NOISE SIMULATION

ENGINEERING ANALYSIS INC
715 ARCADIA CIRCLE
HUNTSVILLE, AL 35801-5909
02.03-9391 (MSFC)
FRANK B. TATOM: 205-533-9391
CALCULATION OF SURFACE PRESSURE FLUCTUATIONS BASED ON TIME-AVERAGED TURBULENT FLOW COMPUTATIONS

ALABAMA CRYOGENIC ENGINEERING INC
PO BOX 2470
HUNTSVILLE, AL 35804
11.03-8629C (MSFC)
MARY T. HENDRICKS: 205-536-8629
ORTHO-PARA CONVERSION IN SPACE-BASED HYDROGEN DEWAR SYSTEMS

CFD RESEARCH CORP
3313 BOB WALLACE AVENUE SUITE 205
HUNTSVILLE, AL 35805
04.10-6576 (MSFC)
DR. ASHOK K. SINGHAL: 205-536-6576
A MATHEMATICAL MODEL TO INVESTIGATE UNDERCUTTING AND TO OPTIMIZE WELD QUALITY

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HUNTSVILLE, AL 35805
01.02-6576 (LeRC)
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RAPID MIX CONCEPTS FOR LOW EMISSION COMBUSTORS IN GAS TURBINE ENGINES

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3313 BOB WALLACE AVENUE SUITE 201
HUNTSVILLE, AL 35805
09.13-8122 (MSFC)
LAWRENCE W. SPARDLEY: 205-536-8122
FINITE-ELEMENT/ADAPTIVE GRID THERMAL ANALYZER WITH ENHANCED GRAPHICS CAPABILITY

REMTECH INC
3304 WESTMILL DRIVE
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CHARLES E. FULLER: 205-536-8581
INTEGRATED CAD VENTING ANALYSIS PACKAGE

REMTECH INC
3304 WESTMILL DRIVE
HUNTSVILLE, AL 35805
02.05-8581 (MSFC)
CHARLES E. FULLER: 205-536-8581
COUPLING OF UNSTEADY FLUID DYNAMICS AND STRUCTURE IN LOW DENSITY HIGH SPEED FLOWS

SECA INC
3311 BOB WALLACE AVENUE SUITE 203
HUNTSVILLE, AL 35805
11.02-2008 (MSFC)
DR. RICHARD C. FARMER: 205-534-2008
HEAT TRANSFER IN ROCKET ENGINE COMBUSTION CHAMBERS AND REGENERATIVELY COOLED NOZZLES

ARIZONA

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TUCSON, AZ 85706
04.15-1980 (JSC)
R.O. LOUTFY: 602-574-1980
A WHISKER REINFORCED HIGH TEMPERATURE STRUCTURAL INSULATION

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3415 LOMITA BOULEVARD
TORRANCE, CA 90505
03.03-8228A (LaRC)
ANDREW M. SKOW: 213-326-8228
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06.04-0885 (ARC)
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14.03-0311 (JPL)
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10.01-4310 (LeRC)
GARY O. FITZPATRICK: 619-455-4310
NEW THERMIONIC CONVERTER FOR OUT-OF-CORE SPACE POWER SYSTEM

ENERGY SCIENCE LABORATORIES INC
10955 JOHN J. HOPKINS DRIVE
SAN DIEGO, CA 92121
10.01-4688 (LeRC)
JAMES R. CLINTON: 619-455-4688
COMPOSITE REGENERATOR FOR STIRLING ENGINE

DEMOGRAFX
10720 HEPBURN CIRCLE
CULVER CITY, CA 90232
06.06-2985 (ARC)
GARY DEMOS: 213-837-2985
APPLICATION OF HIGH PERFORMANCE DIGITAL VIDEO TO COMPUTER STORAGE

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JOHN J. GALLOGLY: 213-698-8061
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PACOIMA, CA 91331
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ROBERT H. TUFFIAS, PH.D.: 818-899-0236
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THOUSAND OAKS, CA 91360
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ROBERT A. BASSETT: 805-495-8265
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RICH EDWARDS: 714-371-4704
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ENCINITAS, CA 92024
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JUNE Y. HOFFMAN: 619-944-7001
CLOUD TOP RADIOMETER

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COSTA MESA, CA 92626
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JOHN J. STUART, JR.: 714-549-8211
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3001 REDHILL AVE BUILDING 3 SUITE 208
COSTA MESA, CA 92626
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JOHN J. STUART JR.: 714-549-8211
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PDA ENGINEERING
2975 REDHILL AVENUE
COSTA MESA, CA 92626
11.04-8900A (MSFC)
LYNN SHERIDAN: 714-540-8900
PHYSICALLY BASED FAILURE CRITERIA FOR CARBON-PHENOLIC MATERIALS

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1721 WHITTIER AVENUE, SUITE A
COSTA MESA, CA 92627
13.01-6239 (KSC)
MARGO BOWERS: 714-722-6239
A REAL TIME PARTICLE FALL-OUT MONITOR

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03.10-0753 (ARC)
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A KNOWLEDGE BASED SIMULATION DESIGN, DEVELOPMENT AND CODING ENVIRONMENT

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IRVINE, CA 92714-6428
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PALO ALTO, CA 94302
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GENERAL TIME-DOMAIN UNSTEADY AERODYNAMICS OF ROTORS

DEACON RESEARCH
900 WELCH ROAD, SUITE 203
PALO ALTO, CA 94304
02.04-1520 (ARC)
OLIVE LEE: 415-326-1520
REMOTE MEASUREMENT SYSTEM FOR ARC JET TEMPERATURE AND DENSITY

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560 SAN ANTONIO ROAD, SUITE 101
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04.05-7351 (LeRC)
DR. CONOR D. JOHNSON: 415-494-7351
DEVELOPMENT OF ADVANCED FINITE ELEMENTS FOR STRUCTURAL ANALYSIS

ELECTRO-OPTICS TECHNOLOGY INC
4057 CLIPPER COURT
FREMONT, CA 94538
08.08-4022 (MSFC)
KIM ROBERT MACK: 415-651-4022
MULTIPLE DIODE PUMPED Ho:Tm:YAG PLANAR RING LASER

APPLIED AND THEORETICAL MECHANICS INC
4501 SEQUOYAH ROAD
OAKLAND, CA 94605
02.01-1427 (ARC)
DR. JOELLE M. CHAMPNEY: 415-635-1427
TWO EQUATION TURBULENCE MODELING OF HYPERSONIC TRANSITIONAL FLOWS WITH UPS CODE

QUANTEL INTERNATIONAL
3150 CENTRAL EXPRESSWAY
SANTA CLARA, CA 95051
08.02-3240 (GSFC)
NESTOR CLOUGH: 408-727-3240
DIODE-PUMPED SHORT-PULSE LASER FOR RANGING AND ALTIMETRY

INTEGRATED SYSTEMS INC
2500 MISSION COLLEGE BOULEVARD
SANTA CLARA, CA 95054-1215
09.01-1500 (LaRC)
MICHAEL G. LYONS: 408-980-1500
CONTROL STRUCTURE INTERACTION: OPTIMIZATION BASED DESIGN TOOLS

GALLOWAY RESEARCH
795 BEAVER CREEK WAY
SAN JOSE, CA 95133
06.01-2490 (LaRC)
JOHN R. GALLOWAY, JR.: 408-259-2490
THE LAFS KERNEL FILE SYSTEM

MOLLER INTERNATIONAL INC
1222 RESEARCH PARK DRIVE
DAVIS, CA 95616
01.02-5086 (LeRC)
PAUL S. MOLLER: 916-756-5086
EVALUATION OF PS200 COATING AS A THERMAL BARRIER IN AN AIR-COOLED ROTARY ENGINE

COLORADO

UNIQUE MOBILITY INC
3700 SOUTH JASON ST
ENGLEWOOD, CO 80110
05.07-2137 (LeRC)
JOHN S. GOULD: 303-761-2137
ROBOTIC ACTUATOR OPTIMIZATION

ADA TECHNOLOGIES INC
304 INVERNESS WAY SOUTH, SUITE 480
ENGLEWOOD, CO 80112
12.02-5615 (MSFC)
JUDITH A. ARMSTRONG: 303-792-5615
INCIPIENT COMBUSTION MONITOR FOR ZERO GRAVITY ENVIRONMENTS

HYDROGEN CONSULTANTS INC
12420 N. DUMONT WAY
LITTLETON, CO 80125
10.01-7972 (LeRC)
GREGORY J. EGAN: 303-791-7972
CONSTANT TEMPERATURE HEAT STORAGE IN METAL HYDRIDES

BEGEJ CORP
5 CLARET ASH ROAD
LITTLETON, CO 80127
05.04-5042 (JSC)
STEFAN BEGEJ: 303-973-5042
GLOVE CONTROLLER WITH FORCE AND TACTILE FEEDBACK FOR DEXTEROUS ROBOTIC HANDS

OPHIR CORP
3190 S. WADSWORTH BLVD, SUITE 100
LAKEWOOD, CO 80227
13.03-1512 (KSC)
DONALD ROTTNER: 303-986-1512
A NOVEL LASER SYSTEM FOR FORECASTING AND MITIGATING LIGHTNING STRIKES

COLORADO RESEARCH DEVELOPMENT CORP
621 17TH STREET, SUITE 1620
DENVER, CO 80293-1601
06.01-8633 (LaRC)
JACK E. DEETER: 303-293-8633
PARALLEL MULTILEVEL ADAPTIVE METHODS FOR FLOWS IN TRANSITION

VEXTRA CORP
2477 55TH STREET
BOULDER, CO 80301
07.02-0094 (GSFC)
W. KOBER: 303-444-0094
HIRIS-ORIENTED VISUALIZATION SOFTWARE SYSTEM

AEROSPACE DESIGN & DEVELOPMENT INC
PO BOX 672
NIWOT, CO 80544
13.04-2888 (KSC)
H.L. GIER: 303-530-2888
SUPERCRITICAL CRYOGENIC SELF-CONTAINED BREATHING APPARATUS

APTEK INC
1257 LAKE PLAZA DRIVE
COLORADO SPRINGS, CO 80906
12.06-8100 (JSC)
THOMAS F.V. MEAGHER: 719-576-8100
AUTOMATION OF STOWAGE

CONNECTICUT

SCIENTIFIC RESEARCH ASSOCIATES INC
PO BOX 1058, 50 NYE ROAD
GLASTONBURY, CT 06033
01.01-0333B (LeRC)
DR. STEPHEN J. SHAMROTH: 203-659-0333
FLOW IN TURBINE BLADE PASSAGES

SCIENTIFIC RESEARCH ASSOCIATES INC
PO BOX 1058, 50 NYE ROAD
GLASTONBURY, CT 06033
11.02-0333 (MSFC)
STEPHEN J. SHAMROTH: 203-659-0333
AN EULERIAN-LAGRANGIAN ANALYSIS FOR LIQUID FLOWS WITH VAPOR BUBBLES

PHONON CORP
7 HERMAN DRIVE, P.O. BOX 549
SIMSBURY, CT 06070
14.02-0211 (GSFC)
TOM MARTIN: 203-651-0211
SURFACE ACOUSTIC WAVE SPECTRAL LIMITER FOR NARROW BAND INTERFERENCE SUPPRESSION

MATERIALS TECHNOLOGIES CORP
57 MARYANNE DRIVE
MONROE, CT 06468
08.12-5200 (ARC)
DR. YOGESH MEHROTRA: 203-261-5200
NOVEL MATERIAL AND FABRICATION TECHNOLOGY FOR HIGH PRECISION LIGHTWEIGHT OPTICS

SCHMITT TECHNOLOGY ASSOC
25 SCIENCE PARK
NEW HAVEN, CT 06511
08.18-5130 (GSFC)
JEROME J. SCHMITT: 203-786-5130
GAS JET DEPOSITION OF OPTICAL THIN FILMS FOR EXTREME ULTRA-VIOLET AND SOFT X-RAY APPLICATIONS

ADVANCED TECHNOLOGY MATERIALS INC
520-B DANBURY ROAD
NEW MILFORD, CT 06776
04.17-2681 (LeRC)
E. G. BANUCCI: 203-355-2681
NOVEL PROCESS FOR THE THIN FILM GROWTH OF YTTRIUM-BARIUM-CUPRATE

ADVANCED TECHNOLOGY MATERIALS INC
520-B DANBURY ROAD
NEW MILFORD, CT 06776
08.01-2681 (JPL)
E.G. BANUCCI: 203-355-2681
NOVEL MERCURY CADMIUM TELLURIDE GROWTH PROCESS

TRANSITIONS RESEARCH CORP
15 GREAT PASTURE ROAD
DANBURY, CT 06810
05.08-8988 (KSC)
J. F. ENGELBERGER: 203-798-8988
TORTUOUS-PATH ROBOT TRANSPORT

FLORIDA

FLORIDA MAXIMA CORP
2180 FORREST ROAD
WINTER PARK, FL 32789
12.05-9275 (ARC)
JAMES E. DRISKELL, PH.D.: 407-644-9275
PERFORMANCE OF GROUPS IN EXTREME ENVIRONMENTS: A META-ANALYTIC INTEGRATION

SCHWARTZ ELECTRO-OPTICS INC
3404 N. ORANGE BLOSSOM TRAIL
ORLANDO, FL 32804
08.04-1802 (LeRC)
E. ADAMKIEWICZ: 407-298-1802
NOVEL COBALT-DOPED MAGNESIUM FLUORIDE LIDAR FOR AEROSOL PROFILER

PHOTONIC SYSTEMS INC
1900 S. HARBOR CITY BLVD
MELBOURNE, FL 32901
07.05-8181 (GSFC)
DENNIS R. PAPE: 407-984-8181
WIDEBAND MULTI-CHANNEL ACOUSTO-OPTIC SPECTROMETER FOR RADIO ASTRONOMY APPLICATIONS

SOFTWARE PRODUCTIVITY SOLUTIONS INC
POST OFFICE BOX 361697
MELBOURNE, FL 32936-1697
06.05-3370 (JSC)
EDWARD R. COMER: 407-984-3370
PASSIVE KNOWLEDGE ACQUISITION SYSTEM

SOFTWARE PRODUCTIVITY SOLUTIONS INC
POST OFFICE BOX 361697
MELBOURNE, FL 32936-1697
06.02-3370 (GSFC)
EDWARD R. COMER: 407-984-3370
CASE VISUALIZATION SYSTEM

ENSCO INC
445 PINEDA COURT
MELBOURNE, FL 32940
13.03-4122 (KSC)
NORMAN BUSH: 703-321-9000
METEROLOGICAL MONITORING SYSTEM

GEORGIA

QUANTA INC
2778 HARGROVE ROAD, SUITE 345
SMYRNA, GA 30080
09.09-9511 (JSC)
GARY V. MCMURRAY: 404-955-5811
UNIVERSAL BILATERAL ROBOTIC CONTROLLER

SEARCH TECHNOLOGY INC
4725 PEACHTREE CORNERS CIRCLE, SUITE 200
NORCROSS, GA 30092
03.09-1457B (LaRC)
RUSTON M. HUNT: 404-441-1457
METHODS AND TOOLS FOR ASSESSING LIMITS OF SYSTEM INTELLIGENCE

HAWAII

SETS INC
300 KAHELU AVENUE
MILILANI, HI 96789
08.15-5262B (JPL)
DR. JONATHAN GRADIE: 808-625-5262
ATMOSPHERIC OPACITY MONITOR

ILLINOIS

INTERSONICS INC
3453 COMMERICAL AVENUE
NORTHBROOK, IL 60062
15.01-1772 (MSFC)
DR. CHARLES A. REY: 312-272-1772
STABILIZED ELECTROMAGNETIC LEVITATOR

BIO-IMAGING RESEARCH INC
425 BARCLAY BOULEVARD
LINCOLNSHIRE, IL 60069
11.04-6425 (MSFC)
ELLEN M. SINGER: 312-634-6425
SLIT DIGITAL RADIOGRAPHY FOR ANALYSIS OF BOND DEFECTS IN ROCKET MOTORS

CONSTRUCTION TECHNOLOGY LABORATORIES INC
5420 OLD ORCHARD ROAD
SKOKIE, IL 60077
04.18-7500 (JSC)
MARTY J. SZCZECH: 312-965-7500
FEASIBILITY STUDY FOR LUNAR CEMENT PRODUCTION

INDIANA

STAR ENTERPRISES INC
PO BOX 1748
BLOOMINGTON, IN 47402
12.11-3309 (ARC)
JEFFREY R. ALBERTS: 812-855-3309
AUTOMATED FOOD DELIVERY TO RODENTS IN SPACE

IOWA

IOWA THIN FILM TECHNOLOGIES INC
237 WILDFLOWER DRIVE
AMES, IA 50010
10.01-3203 (LeRC)
DERRICK GRIMMER: 515-294-7732
FLEXIBLE, LIGHTWEIGHT AMORPHOUS SILICON SOLAR CELLS TUNED FOR AMO SPECTRUM

ACCEL CATALYSIS INC
TECHNOLOGY INNOVATION CENTER, UV OF IOWA
IOWA CITY, IA 52242
11.01-4577 (LeRC)
DARRELL P. EYMAN: 319-335-1359
A CATALYTIC THERMAL MANAGEMENT SYSTEM FOR HYDROGEN-FUELED INJECTION VEHICLES

KANSAS

B&D INSTRUMENTS AND AVIONICS
209 W. MAIN
VALLEY CENTER, KS 67147
03.06-1223 (ARC)
HOWARD BOTTS: 316-755-1223
EVALUATION OF PVDF FILM AS A PRESSURE SENSOR

LOUISIANA

TECHNOLOGY INTERNATIONAL INC
429 WEST AIRLINE HIGHWAY, SUITE S
LAPLACE, LA 70068
07.03-1127 (SSC)
ZEINAB A. SABRI: 504-652-1127
APPLICATION OF FRACTALS TO SMOOTHING OVER THE PARAMETER SPACE

MARYLAND

RESSLER ASSOCIATES INC
14440 CHERRY LANE COURT SUITE 212
LAUREL, MD 20707
08.05-3232 (GSFC)
GERALD M. RESSLER: 301-206-3232
AN AIRBORNE LASER DEPOLARIZATION IMAGING SENSOR FOR TERRESTRIAL MEASUREMENTS

EASTERN ANALYTICAL INC
335 PAINT BRANCH DR
COLLEGE PARK, MD 20742
12.01-77511 (JSC)
LARRY J. MOORE: 301-454-7751
SELECTIVE ENRICHMENT OF CALCIUM STABLE ISOTOPES USING LASER TECHNIQUES

FARE INC
7210 WINDSOR LANE
HYATTSVILLE, MD 20782
04.11-7412 (GSFC)
JAMES A. KIRK: 301-277-7412
A COMPOSITE MATERIAL FLYWHEEL FOR ENERGY STORAGE

APPLIED RESEARCH CORP
8201 CORPORATE DRIVE, SUITE 920
LANDOVER, MD 20785
08.21-8442 (JSC)
ANDREW S. ENDAL: 301-459-8442
HIGHLY TRANSPARENT AND RUGGED SENSOR FOR METEOROIDS AND SPACE DEBRIS

FOA ENGINEERING
3404 THORNAPPLE ST.
CHEVY CHASE, MD 20815
01.04-2685 (LeRC)
JOSEPH V. FOA: 301-656-2685
HIGH-EFFICIENCY FLOW INDUCTION

INTERDISCIPLINARY SCIENCE APPLICATIONS
613 MURIEL STREET
ROCKVILLE, MD 20852
08.02-7518A (GSFC)
B. KEDEM: 301-770-7518
A STOCHASTIC RAIN MODEL AND ITS APPLICATION IN RAIN RATE ESTIMATION

INTELLIGENT AUTOMATION INC
1715 GLASTONBERRY ROAD
ROCKVILLE, MD 20854
05.03-40071 (GSFC)
LEONARD S. HAYNES: 301-424-4007
TELEROBOT CONTROL INTERFACE BASED ON CONSTRAINTS

INFRARED FIBER SYSTEMS INC
2301-A BROADBIRCH DRIVE
SILVER SPRING, MD 20904
08.13-9546 (GSFC)
KENNETH LEVIN: 301-622-9546
INFRARED FIBER ARRAYS FOR LOW BACKGROUND INFRARED ASTRONOMY

SCIENCE & ENGINEERING SERVICES INC
17 SERPENTINE CT.
SILVER SPRING, MD 20904
08.06-4161 (GSFC)
HYO SANG LEE: 301-236-4161
SYSTEMS FOR CONTINUOUS TUNING AND SINGLE MODE OPERATION OF SOLID STATE LASERS

NEW HORIZONS DIAGNOSTICS
9110 RED BRANCH RD
COLUMBIA, MD 21045
12.08-9357 (JSC)
LARRY LOOMIS: 301-992-9357
DEVICE FOR SAMPLE COLLECTION AND RAPID IMMUNOLOGICAL IDENTIFICATION OF BIOLOGICAL SPECIMENS

BRIMROSE CORPORATION OF AMERICA
5020 CAMPBELL BOULEVARD, BLDG 1
BALTIMORE, MD 21236
15.02-5800 (LeRC)
DR. R. G. ROSEMEIER: 301-529-5800
NOVEL 'IN SITU' TECHNIQUE TO VISUALIZE CONVECTION ON SOLID-LIQUID INTERFACES

MASSACHUSETTS

MILLITECH CORP
PO BOX 109 SOUTH DEERFIELD RESEARCH PARK
SOUTH DEERFIELD, MA 01373
08.09-8551 (MSFC)
WILLIE S. DAY: 413-665-8551
A BROADBAND MULTICHANNEL PRECIPITATION SENSOR

OPTRON SYSTEMS INC
3 PRESTON COURT
BEDFORD, MA 01730
14.01-3100 (JSC)
DR. CARDINAL WARDE: 617-275-3100
AN ELECTRO-OPTIC MODULATOR FOR LASER WAVEFRONT CORRECTION AND POSITIONING IN SPACE

OPTRON SYSTEMS INC
3 PRESTON COURT
BEDFORD, MA 01730
08.13-3100 (GSFC)
CARDINAL WARDE: 617-275-3100
LOW-COST IMAGING ELECTRON MULTIPLIER DEVICE

OPTRON SYSTEMS INC
3 PRESTON COURT
BEDFORD, MA 01730
09.09-3100 (JSC)
DR. CARDINAL WARDE: 617-275-3100
LOW-VOLTAGE THIN-FILM ELECTROLUMINESCENT PHOSPHOR

SPIRE CORP
PATRIOTS PARK
BEDFORD, MA 01730
10.04-6000 (LaRC)
RICHARD GREGORIO: 617-275-6000
VERTICAL, MULTIJUNCTION, PHOTOVOLTAIC CELLS WITH BURIED SILICIDE INTERCONNECTIONS

SPIRE CORP
PATRIOTS PARK
BEDFORD, MA 01730
14.05-6000A (LeRC)
RICHARD GREGORIO: 617-275-6000
HIGH-INDIUM-CONTENT HIGH ELECTRON MOBILITY TRANSISTORS FOR RF COMMUNICATIONS DEVICES

SPIRE CORP
PATRIOTS PARK
BEDFORD, MA 01730
08.07-6000A (LaRC)
RICHARD S. GREGORIO: 617-275-6000
DEVELOPMENT OF 780NM AND 792 DIODE LASER PUMPS FOR SOLID STATE LASERS

SCHWARTZ ELECTRO-OPTICS INC
45 WINTHROP STREET
CONCORD, MA 01742
08.07-2299 (LaRC)
PETER F. MOULTON: 508-371-2299
LASERS OPTIMIZED FOR PUMPING TITANIUM-ALUMINA LASERS

SCHWARTZ ELECTRO-OPTICS INC
45 WINTHROP STREET
CONCORD, MA 01742
15.02-2299 (LeRC)
PETER F. MOULTON: 508-371-2299
SPACE-QUALIFIED LASER FOR MICROGRAVITY EXPERIMENTS

CPS SUPERCONDUCTOR CORP
155 FORTUNE BOULEVARD
MILFORD, MA 01757
04.17-3422A (LeRC)
CHARLES N. MCCORMACK: 508-634-3422
ULTRARAPID TEXTURED GROWTH OF YTTRIUM-BARIUM-CUPRATE FILAMENTS FOR COMPOSITE HTSC WIRE

CASTLE TECHNOLOGY CORP
262 WEST CUMMINGS PARK
WOBURN, MA 01801
04.17-5634 (MSFC)
J. PAUL PEMSLER: 617-933-5634
INCREASING CRITICAL CURRENT DENSITIES IN HIGH-Tc SUPERCONDUCTORS

SCIENTIFIC SYSTEMS
500 WEST CUMMINGS PARK SUITE 3950
WOBURN, MA 01801
03.05-5355 (ARC)
DR. RAMAN K. MEHRA: 617-933-5355
REAL-TIME ADAPTIVE IDENTIFICATION AND PREDICTION OF FLUTTER

ATLANTIC APPLIED RESEARCH CORP
4 A STREET
BURLINGTON, MA 01803
02.02-0559 (LaRC)
ROBERT J. CARVER: 617-273-2400
WIND TUNNEL NOISE REDUCTION

PHYSICAL SCIENCES INC
PO BOX 3100, RESEARCH PARK
ANDOVER, MA 01810-7100
01.01-9030A (LeRC)
B. DAVID GREEN: 508-475-9030
REACTION MECHANICS AND KINETIC RATES FOR SOOT FORMATION

PHYSICAL SCIENCES INC
PO BOX 3100, RESEARCH PARK
ANDOVER, MA 01810-7100
01.03-9030 (LeRC)
B. DAVID GREEN: 508-475-9030
LASER-INDUCED FLUORESCENCE MEASUREMENTS OF VELOCITY IN SUPERSONIC REACTING FLOWFIELDS

PHYSICAL SCIENCES INC
PO BOX 3100, RESEARCH PARK
ANDOVER, MA 01810-7100
02.04-9030 (JSC)
BYRON DAVID GREEN: 508-475-9030
HIGH VELOCITY GAS SURFACE ACCOMMODATION

AERODYNE RESEARCH INC
45 MANNING ROAD
BILLERICA, MA 01821
13.06-9500 (JSC)
DR. HERMAN E. SCOTT: 508-663-9500
TEMPERATURE/SHOCK POSITION SENSOR FOR HIGH PRESSURE OXYGEN SYSTEMS

AUTOMATIX INC
755 MIDDLESEX TURNPIKE
BILLERICA, MA 01821
04.10-7900 (MSFC)
DR. DONALD L. PIEPER: 508-667-7900
MACRO AND TASK-LEVEL PROGRAMMING OF ARC WELDING ROBOTS FOR AEROSPACE APPLICATIONS

TECH. INTEGRATION & DEVELOP. GROUP INC
ONE PROGRESS ROAD
BILLERICA, MA 01821
15.05-3779 (MSFC)
RICHARD E. HAYDEN: 508-667-3779
AUTOMATIC FAULT DETECTION AND FAILURE PREDICTION FOR SPACECRAFT SYSTEMS

BARR ASSOCIATES INC
2 LYBERTY WAY
WESTFORD, MA 01886
08.18-7513B (JPL)
JEFFREY MACLAREN: 508-692-7513
ION BEAM DEPOSITION OF LARGE AREA, LOW SCATTERING METAL COATINGS

MÓCO INC
91 SURFSIDE RD PO BOX A
SCITUATE, MA 02055-0974
12.05-2040 (JSC)
RICHARD H. ECKHOUSE JR. PH.D: 617-545-2040
OPTIMAL WORKSPACE DESIGN

EIC LABORATORIES INC
111 DOWNEY STREET
NORWOOD, MA 02062
08.12-9450 (ARC)
DR. A. C. MAKRIDES: 617-769-9450
EFFICIENT FAR-INFRARED INDUCTIVE MESH FILTERS BY PHOTOELECTROCHEMICAL ETCHING

EIC LABORATORIES INC
111 DOWNEY STREET
NORWOOD, MA 02062
08.18-9450 (GSFC)
A. C. MAKRIDES: 617-769-9450
PHOTOETCHED ECHELLE GRATINGS IN SILICON

EIC LABORATORIES INC
111 DOWNEY STREET
NORWOOD, MA 02062
10.07-9450 (JPL)
A. C. MAKRIDES: 617-769-9450
ROBUST HIGH Tc RIBBON FOR POWER TRANSMISSION

DATAFLOW COMPUTER CORP
85 EAST INDIA ROW
BOSTON, MA 02110
06.06-2748A (ARC)
JACK B. DENNIS: 617-484-8932
PROGRAM MAPPING STRATEGIES FOR MULTIPROCESSOR COMPUTERS

CHEMICAL TESTING AND CONSULTING CO
64 PINCKNEY STREET, UNIT #3
BOSTON, MA 02114
12.09-0966 (MSFC)
SHARON CUNNINGHAM: 617-720-0966
CHEMICAL SENSOR SYSTEM FOR THE IDENTIFICATION OF ORGANIC COMPOUNDS IN WATER

BARRETT DESIGN INC
230 WESTERN AVENUE
BOSTON, MA 02134
05.04-3909 (JSC)
WILLIAM T. TOWNSEND: 617-787-3909
A WRIST USING NEW MECHANISM TECHNOLOGY INVENTED FOR WHOLE-ARM MANIPULATION

CHARLES RIVER ANALYTICS INC
55 WHEELER STREET
CAMBRIDGE, MA 02138
09.02-3474 (LaRC)
ALPER K. CAGLAYAN: 617-491-3474
A NEURAL NET APPROACH TO SPACE VEHICLE GUIDANCE

PHOTON RESEARCH ASSOCIATES INC
1033 MASSACHUSETTS AVENUE
CAMBRIDGE, MA 02138
08.03-1522 (SSC)
DR. JAMES C. FRASER: 617-354-1522
MULTISPECTRAL REMOTE SENSING USING SPRITE TECHNOLOGY

AXIOMATICS CORP
60 ROGERS ST
CAMBRIDGE, MA 02142
12.12-6700 (KSC)
CRAIG R. DAVIS: 617-497-6700
REMOTE MOISTURE SENSOR TO CONTROL IRRIGATION OF PLANTS IN SPACE

SATCON TECHNOLOGY CORP
71 ROGERS STREET
CAMBRIDGE, MA 02142-1118
04.15-0540 (JSC)
DAVID B. EISENHAURE: 617-661-0540
DIRECT MEASURMENT OF BOLT TENSION UTILIZING MAGNETOSTRICTION

SATCON TECHNOLOGY CORP
71 ROGERS STREET
CAMBRIDGE, MA 02142-1118
04.14-0540 (JPL)
DAVID B. EISENHAURE: 617-661-0540
MAGNETOSTRICTIVE ACTIVE MEMBER FOR CONTROL OF SPACE STRUCTURES

SATCON TECHNOLOGY CORP
71 ROGERS STREET
CAMBRIDGE, MA 02142-1118
10.01-0540 (MSFC)
DAVID B. EISENHAURE: 617-661-0540
INTEGRATED POWER AND ATTITUDE CONTROL SYSTEM FOR THE SPACE STATION AND OTHER APPLICATIONS

SCIENCE RESEARCH LABORATORY INC
15 WARD STREET
SOMERVILLE, MA 02143
08.08-1122A (MSFC)
JONAH JACOB: 617-547-1122
COMPACT, LIGHTWEIGHT EXPANDING BEAM CO2 LASER AMPLIFIERS FOR SPACEBOARD APPLICATIONS

TRACER TECHNOLOGIES INC
20 ASSEMBLY SQUARE DR
SOMERVILLE, MA 02145
09.07-6410 (GSFC)
ALFRED AJAMI: 617-776-6410
A LOW-THERMAL-CONDUCTIVITY CONNECTOR

NEKTONICS INC
400 FIFTH AVENUE
WALTHAM, MA 02154
02.03-5750 (LaRC)
ANTHONY T. PATERA: 617-290-5750
TRANSITION TO TURBULENCE IN COMPLEX AERODYNAMIC FLOWS

GEO-CENTERS INC
7 WELLS AVENUE
NEWTON CENTRE, MA 02159
12.12-7070 (KSC)
EDWARD P. MARRAM: 617-964-7070
TRACE CONTAMINANT VAPOR MONITORS

RADIATION MONITORING DEVICES INC
44 HUNT STREET
WATERTOWN, MA 02172
04.17-1167 (LaRC)
GERALD ENTINE: 617-926-1167
HIGH FIELD, HIGH Tc SUPERCONDUCTING MAGNETS

RADIATION MONITORING DEVICES INC
44 HUNT STREET
WATERTOWN, MA 02172
12.01-1167 (JSC)
GERALD ENTINE, PH.D.: 617-926-1167
SOLID STATE NEUTRON DOSIMETER FOR SPACE APPLICATIONS

FOSTER-MILLER INC
350 SECOND AVENUE
WALTHAM, MA 02254
04.03-3200 (LaRC)
ADI R. GUZDAR: 617-890-3200
LARC-TPI/LIQUID CRYSTAL POLYMER BLENDS

FOSTER-MILLER INC
350 SECOND AVENUE
WALTHAM, MA 02254
09.05-3200 (MSFC)
ADI R. GUZDAR: 617-890-3200
NOVEL COMPOSITES FOR PROTECTION AGAINST ORBITAL DEBRIS

FOSTER-MILLER INC
350 SECOND AVENUE
WALTHAM, MA 02254
09.12-3200 (GSFC)
ADI R. GUZDAR: 617-890-3200
HEAT PUMP FOR SPACE THERMAL BUS

FOSTER-MILLER INC
350 SECOND AVENUE
WALTHAM, MA 02254
04.01-3200 (LeRC)
ADI R. GUZDAR: 617-890-3200
HIGH-TEMPERATURE-FILM BASED POLYBENZOXAZOLE/POLYMIDE MICROCOMPOSITE FOR TURBINE ENGINES

FOSTER-MILLER INC
350 SECOND AVENUE
WALTHAM, MA 02254
05.08-3200 (KSC)
ADI R. GUZDAR: 617-890-3200
SELF-CONTAINED DEPLOYABLE SERPENTINE TRUSS FOR PRELAUNCH ACCESS OF ORBITER PAYLOADS

PANAMETRICS INC
221 CRESCENT STREET
WALTHAM, MA 02254
08.22-2719 (LeRC)
CHARLES H. HOGAN: 617-899-2719
CRYOGENIC ULTRASONIC MASS FLOWMETER AND QUALITY METER

GINER INC
14 SPRING STREET
WALTHAM, MA 02254-9147
10.03-7270 (GSFC)
A.B. LACONTI: 617-899-7270
NICKEL-CADMIUM BATTERY SEPARATOR DESIGN AND DEVELOPMENT

CAPE COD RESEARCH INC
PO BOX 600
BUZZARDS BAY, MA 02532
04.11-5911 (GSFC)
KATHERINE D. FINNEGAN: 508-759-5911
IMPROVED ELECTRO-RHEOLOGICAL FLUIDS FOR LUBRICANT VISCOSITY CONTROL

MICHIGAN

KMS FUSION INC
PO BOX 1567, 3853 RESEARCH PARK DRIVE
ANN ARBOR, MI 48106-1567
05.06-8500 (JPL)
ROBERT F. MCCARTHY: 313-769-8500
GLOBAL-LOCAL ENVIRONMENT TELEROBOTIC SIMULATOR

MINNESOTA

APA OPTICS INC
2950 N.E. 84TH LANE
BLAINE, MN 55434
04.16-4995 (JPL)
A.K. JAIN: 612-784-4995
ATOMIC LAYER CVD OF YTTRIUM-BARIUM-CUPRATE OVER A LOW DIELECTRIC SUBSTRATE

APA OPTICS INC
2950 N.E. 84TH LANE
BLAINE, MN 55434
09.09-4995 (JSC)
A.K. JAIN: 612-784-4995
FLAT PANEL MULTICOLOR DISPLAY BASED ON INTEGRATED OPTIC SCANNER

NONVOLATILE ELECTRONICS INC
5805 AMY DRIVE
EDINA, MN 55436
07.09-8659 (JPL)
JAMES M. DAUGHTON: 612-920-8659
ULTRA-DENSE MAGNETRORESISTIVE MASS MEMORY

MISSISSIPPI

SPATIAL INFORMATION SCIENCES INC
MISSISSIPPI TECH TRANSFER OFFICE
STENNIS SPACE CENTER, MS 34529
07.04-6685 (SSC)
J. FRANK HEBARD: 703-430-6685
RASTER AND VECTOR DATA INTEGRATION, INTERACTIVE EDIT AND ANALYSIS

MONTANA

TMA TECHNOLOGIES INC
PO BOX 3118
BOZEMAN, MT 59715
08.19-5976 (GSFC)
WILLIAM J. SENECAL: 406-586-7684
BROADBAND SOURCE DEVELOPMENT FOR A THREE-DIMENSIONAL REFLECTOMETER

NEVADA

ROCKY RESEARCH
PO BOX 1086
BOULDER CITY, NV 89005
09.11-0851A (JSC)
UWE ROCKENFELLER: 702-293-0851
HIGH-DENSITY, CHEMICAL THERMAL STORAGE SYSTEM FOR LOW GRAVITY ENVIRONMENTS

ROCKY RESEARCH
PO BOX 1086
BOULDER CITY, NV 89005
09.13-0851A (MSFC)
UWE ROCKENFELLER: 702-293-0851
HIGH-LIFT, HEAT-ACTUATED, SOLID-VAPOR HEAT PUMP FOR SIMULTANEOUS REFRIGERATION AND WATER HEATING

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CREARE INC
PO BOX 71, ETNA ROAD
HANOVER, NH 03755
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JAMES A. BLOCK: 603-643-3800
CONDENSER COMPONENT DESIGN FOR ALKALI METAL THERMOELECTRIC CONVERSION SYSTEMS

CREARE INC
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HANOVER, NH 03755
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JAMES A. BLOCK: 603-643-3800
ADVANCED MODELING OF COMBUSTION SYSTEMS

CREARE INC
PO BOX 71, ETNA ROAD
HANOVER, NH 03755
09.12-3800A (GSFC)
DR. JAMES A. BLOCK: 603-643-3800
MAGNETIC BEARINGS FOR MINIATURE HIGH SPEED TURBOMACHINES

CREARE INC
PO BOX 71, ETNA ROAD
HANOVER, NH 03755
15.03-3800 (LaRC)
DR. JAMES A. BLOCK: 603-643-3800
NUMERICAL MODELING OF PARTICLE FORMATION AND GROWTH DURING CHEMICAL VAPOR DEPOSITION

NEW JERSEY

LIGHT AGE INC
6 POWDER HORN DR
WARREN, NJ 07060
08.06-0600 (GSFC)
PETER MAGNANI: 201-563-0600
SINGLE LONGITUDINAL MODE ALEXANDRITE LIDAR TRANSMITTER

EPITAXX INC
3490 US ROUTE ONE
PRINCETON, NJ 08540
07.06-1188 (LaRC)
DR. GREGORY H. OLSEN: 609-452-1188
VISIBLE SEMICONDUCTOR DIODE LASERS GROWN BY HYDRIDE VAPOR PHASE EPITAXY

EPITAXX INC
3490 US ROUTE ONE
PRINCETON, NJ 08540
08.01-1188 (JPL)
MR. JAMES D. COLEMAN: 609-452-1188
A 128 X 128 ELEMENT INDIUM-GALLIUM-ARSENIDE IR DETECTOR ARRAY AT 300K

AEROCHEM RESEARCH LABORATORIES INC
PO BOX 12
PRINCETON, NJ 08542
02.10-7070 (LeRC)
HARTWELL F. CALCOTE: 609-921-7070
COMPUTER SIMULATION AND DESIGN OF JET NOISE SUPPRESSORS

CONTINUUM DYNAMICS INC
PO BOX 3073
PRINCETON, NJ 08543
02.09-9282 (LaRC)
BARBARA A. HAWK: 609-734-9282
GENERAL FLOW FIELD ANALYSIS METHODS FOR HELICOPTER ROTOR AEROACOUSTICS

TEKNOWLOGICA INC
PO BOX 145
PRINCETON JUNCTION, NJ 08550
01.03-9654A (LeRC)
ROBERT W. MCCULLOUGH: 609-799-9654
NON-INTRUSIVE SINGLE POINT PRESSURE/TEMPERATURE SENSOR FOR AERONAUTICAL PROPULSION APPLICATIONS

CUMBS ASSOCIATES INC
11 HARTS LANE
EAST BRUNSWICK, NJ 08816
04.01-9049 (LeRC)
RONALD W. CUMBS: 201-257-9049
SOLUBLE CONDUCTING POLYMER-BASED CONDUCTIVE COATINGS

NEOCERA ASSOCIATES INC
PO BOX 815
PISCATAWAY, NJ 08855
04.17-2694 (LaRC)
ROGER EDWARDS: 201-647-2694
MICROWAVE-COMPATIBLE HIGH-Tc SUPERCONDUCTING FILMS ON SAPPHIRE SUBSTRATES

NEW MEXICO

SOUTHWEST SCIENCES INC
1570 PACHECO STREET, SUITE E-11
SANTA FE, NM 87501
15.02-1322 (LeRC)
ALAN C. STANTON: 505-984-1322
COMBUSTION DIAGNOSTICS FOR MICROGRAVITY
RESEARCH USING NEAR-INFRARED DIODE LASERS

NEW YORK

PROGRAM DEVELOPMENT CORP OF SCARSDALE
300 HAMILTON AVE SUITE 409
WHITE PLAINS, NY 10601
01.01-1732A (LeRC)
PETER R. EISEMAN: 914-761-1732
TURBO: A GRID GENERATION CODE WITH
AUTOMATIC ZONING

SCS TELECOM INC
107 HAVEN AVENUE
PORT WASHINGTON, NY 11050
09.04-0760 (JSC)
DR. DONALD L. SCHILLING: 516-883-0760
A NOVEL DIRECTION-FINDING TECHNOLOGY FOR
ROBOTIC TRACKING IN THE SPACE STATION

SCS TELECOM INC
107 HAVEN AVENUE
PORT WASHINGTON, NY 11050
14.01-0760A (JSC)
DR. DONALD L. SCHILLING: 516-883-0760
POWER AND BAND WIDTH EFFICIENT DIGITAL
COMMUNICATIONS

HIGH TECHNOLOGY SERVICES INC
250 JORDAN RD SUITE 210
TROY, NY 12180
04.03-8072 (LaRC)
MILTON L. EVANS: 518-283-8072
METHODS FOR PRODUCING FINE PARTICLE
THERMOPLASTIC POLYIMIDE SULFONE POWDER

WILSON GREATBATCH LTD
10,000 WEHRLE DRIVE
CLARENCE, NY 14031
10.02-6901 (JPL)
CURTIS F. HOLMES: 716-759-6901
RECHARGEABLE LITHIUM/TITANIUM DISULFIDE
CELLS WITH LONG CYCLE LIFE

DIMENSION TECHNOLOGIES INC
176 ANDERSON AVENUE
ROCHESTER, NY 14607
06.06-7450 (ARC)
ARNOLD D. LAGERGREN: 716-442-7450
A HIGH RESOLUTION AUTOSTEREOSCOPIC DISPLAY

ODYSSEY RESEARCH ASSOCIATES
301A HARRIS B. DATES DRIVE
ITHACA, NY 14850
06.03-2020 (LaRC)
KENNETH R. MORIN: 607-277-2020
FORMAL VERIFICATION FOR C WITH UNIX

INNOVATIVE DYNAMICS
CORNELL RESEARCH PARK, 244 LANGMUIR LABS
ITHACA, NY 14850-1296
04.06-0533 (LaRC)
JOSEPH J. GERARDI: 607-257-0533
AIRCRAFT HEALTH MONITORING SYSTEM

INNOVATIVE DYNAMICS
CORNELL RESEARCH PARK, 244 LANGMUIR LABS
ITHACA, NY 14850-1296
03.06-0533 (LaRC)
GAIL A. HICKMAN: 607-257-0534
LOW COST ANGLE-OF-ATTACK SENSOR FOR
SUBSONIC AIRCRAFT

NORTH CAROLINA

APPLIED RESEARCH ASSOCIATES INC
6404 FALLS OF NEUSE ROAD SUITE 200
RALEIGH, NC 27615
04.02-0018 (LeRC)
LAWRENCE A. TWISDALE: 919-876-0018
PROBABILISTIC STRUCTURAL MECHANICS
RESEARCH FOR PARALLEL PROCESSING COMPUTERS

OHIO

RIBBON TECHNOLOGY CORP
PO BOX 30758, 825 TAYLOR STATION ROAD
GAHANNA, OH 43230
04.04-5444A (LeRC)
LLOYD HACKMAN: 614-864-5444
RAPIDLY SOLIDIFIED NARROW TITANIUM
ALUMINIDE STRIP

RIBBON TECHNOLOGY CORP
PO BOX 30758, 825 TAYLOR STATION ROAD
GAHANNA, OH 43230
04.09-5444 (LaRC)
LLOYD HACKMAN: 614-864-5444
PROCESS CONTROL FOR MELT OVERFLOW RAPID
SOLIDIFICATION TECHNOLOGY

DIESELDYNE CORP
3044 MIDDLEBORO ROAD
MORROW, OH 45152
03.08-3226B (ARC)
NANCY J. JOHNSTON: 513-899-3226
AN ADVANCED HEAT REJECTION SYSTEM FOR AN
AVCD ENGINE IN A HIGH ALTITUDE RESEARCH
PLATFORM

OREGON

HANSEN RESEARCH ASSOCIATES
PO BOX 30133
EUGENE, OR 97403
02.04-4007 (LaRC)
C. FREDERICK HANSEN: 503-344-4007
TRANSPORT PROPERTIES IN NON-EQUILIBRIUM AIR MIXTURES

UMPQUA RESEARCH COMPANY
PO BOX 791
MYRTLE CREEK, OR 97457
12.03-5201 (JSC)
GERALD V. COLOMBO: 503-863-5201
ELECTROCHEMICAL WATER RECOVERY PROCESS FOR DIRECT REMOVAL OF IMPURITIES

UMPQUA RESEARCH COMPANY
PO BOX 791
MYRTLE CREEK, OR 97457
12.02-5201B (MSFC)
GERALD V. COLOMBO: 503-863-5201
A REAGENTLESS SEPARATOR FOR REMOVAL OF INORGANIC CARBON FROM SOLUTION

UMPQUA RESEARCH COMPANY
PO BOX 791
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12.08-5201 (JSC)
DAVID F. PUTNAM: 503-863-5201
THERMALLY DESORBABLE TOXIN AND ODOR CONTROL CARTRIDGE

BEND RESEARCH INC
64550 RESEARCH ROAD
BEND, OR 97701-8599
12.07-4100A (JSC)
ROD RAY: 503-382-4100
MEMBRANE-BASED HIGH-PRESSURE GAS-DEHYDRATION MODULE

PENNSYLVANIA

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FIVE PPG PLACE
PITTSBURGH, PA 15222
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DR. BRUCE RUSSELL: 412-642-6900
AN EXPERT ADVISOR FOR FAILURE MODE AND EFFECTS ANALYSIS GENERATION

EMEC CONSULTANTS
R.D. 3, ROUNDTOP ROAD
EXPORT, PA 15632
04.18-3260A (JSC)
RUDOLF KELLER: 412-325-3260
PRODUCTION OF OXYGEN BY ELECTROLYSIS OF LUNAR SOIL IN MOLTEN SALT

THERMACORE INC
780 EDEN ROAD
LANCASTER, PA 17601
09.12-6551 (GSFC)
RICHARD W. LONGSDERFF: 717-569-6551
SINTERED POWDER, ARTERY-FREE WICKS FOR LOW TEMPERATURE HEAT PIPES

THERMACORE INC
780 EDEN ROAD
LANCASTER, PA 17601
09.13-6551 (MSFC)
RICHARD W. LONGSDERFF: 717-569-6551
COMPOSITE MATERIAL HEAT PIPE TECHNOLOGY

HITC SUPERCONCO INC
PO BOX 487
NEW HOPE, PA 18938
09.07-9722 (GSFC)
RICHARD B. CASS: 609-397-2900
HIGH TEMPERATURE SUPERCONDUCTOR PASSIVE MAGNETIC BEARING

NUMEDLOC
430 HOLLYBUSH RD
BRYN MAWR, PA 19010
12.14-5668A (KSC)
LON CROSBY, PH.D.: 215-527-4995
ANATOMICAL IMAGE ANALYSIS TECHNIQUES

TEXTILE TECHNOLOGIES INC
2800 TURNPIKE DR
HATBORO, PA 19040
04.03-5325 (LaRC)
STEPHEN P. ZAWISLAK: 215-443-5325
MULTI-ANGULAR WEAVING FOR COMPOSITE PREFORMS

CHI SYSTEMS INC
GWYNEDD PLAZA III
SPRING HOUSE, PA 19477
12.05-1400 (JSC)
DR. FLOYD A. GLENN III: 215-542-1400
CAPTURNG SPACE CREW REPRESENTATIONS OF CONTROL SYSTEMS WITH MULTIDIMENSIONAL SCALING

TENNESSEE

FWG ASSOCIATES INC
217 LAKEWOOD DRIVE
TULLAHOMA, TN 37388
13.03-1982 (MSFC)
DR. WALTER FROST: 615-455-1982
INSTRUMENTED ROCKET WIND PROFILER

ACCURATE AUTOMATION CORPORATION
SUITE A-180, 409 CHESTNUT STREET
CHATTANOOGA, TN 37402
05.09-5959A (MSFC)
ROBERT M. PAP: 615-267-5959
ADVANCED TELEROBOTIC CONCEPTS USING NEURAL NETWORKS

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SCHMIDT INSTRUMENTS INC
2476 BOLSOVER SUITE 234
HOUSTON, TX 77005
08.02-9040 (GSFC)
LILA R. ANDERSON: 713-660-8414
VERY LARGE SCALE INTEGRATION TIME INTERVAL UNITS

SCHMIDT INSTRUMENTS INC
2476 BOLSOVER SUITE 234
HOUSTON, TX 77005
08.20-9040 (GSFC)
LILA R. ANDERSON: 713-660-8414
TIME-OF-FLIGHT MASS SPECTROMETRY INSTRUMENTS FOR MONITORING CONTAMINANTS IN SPACE

LYNNTECH INC
ROUTE 5 BOX 946A
COLLEGE STATION, TX 77840
12.03-4131 (JSC)
WILLIAM B. CRAVEN: 409-846-4131
SOLID POLYMER ELECTROLYTE-BASED ELECTROLYZERS FOR WATER RECLAMATION POST-TREATMENT

MICON ENGINEERING
ONE GRAHAM ROAD
COLLEGE STATION, TX 77840
10.06-8911 (MSFC)
R. PAGE HELLER: 409-690-8911
INTELLIGENT PROTECTION SYSTEM FOR SPACE POWER APPLICATIONS

WINZEN INTERNATIONAL INC
12001 NETWORK BLVD SUITE 200
SAN ANTONIO, TX 78249
09.06-7062 (GSFC)
JAMES L. RAND: 512-692-7062
AUTOMATED SEAL FLAW DETECTION

COMPUTER ALGORITHM DEVELOPMENT
2806 A NUECES
AUSTIN, TX 78705
05.09-6511 (MSFC)
RONALD VANBEEK: 512-474-6511
ACTIVE DETECTION AND TRACKING SENSOR FOR PASSIVE TARGETS

EXFLUOR RESEARCH CORP
PO BOX 7807
AUSTIN, TX 78712
04.11-3812 (GSFC)
RICHARD J. LAGOW: 512-471-1032
NEW PERFLUOROPOLYETHER ELASTOMERS FOR LOW AND HIGH TEMPERATURES

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1406 SMITH ROAD SUITE A
AUSTIN, TX 78721
04.06-0318 (LaRC)
CLAYTON A.T. NYBERG: 512-385-0318
DIGITAL OPTICAL PHASE-LOCK-LOOP FOR NON-DESTRUCTIVE EVALUATION

GALAXY MICROSYSTEMS INC
10711 BURNET RD SUITE 325
AUSTIN, TX 78758
14.02-7606 (GSFC)
ROBERT E. FOSDICK: 512-836-7606
HIGH SPEED DIGITAL DATA TRANSMISSION

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IOMED INC
2320 S. 1290 W., SUITE A
SALT LAKE CITY, UT 84108
12.01-1191 (JSC)
STEVEN H. OBER: 801-975-1191
TRANSDERMAL DRUG DELIVERY SYSTEM FOR APPLICATION IN SPACE FLIGHT

SARCOS RESEARCH CORP
261 E. 300 S. SUITE 150
SALT LAKE CITY, UT 84111
05.03-0559B (GSFC)
JOHN F. GRENNAN: 801-531-0560
HIGH PERFORMANCE MULTIAXIS STRAIN SENSING

SARCOS RESEARCH CORP
261 E. 300 S. SUITE 150
SALT LAKE CITY, UT 84111
12.07-0559A (JSC)
JOHN F. GRENNAN: 801-531-0559
USING ROBOTS IN THE TESTING OF NASA EVA SPACE SUITS

VIRGINIA

CORDEC CORP
8270-B CINDER BED ROAD -- P.O. BOX 188
LORTON, VA 22079-0188
04.04-8044 (LaRC)
HELEN PIERIDES: 703-550-8044
MICROSTRUCTURALLY TOUGHENED INTERMETALLIC MATRIX COMPOSITES

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8270-B CINDER BED ROAD -- P.O. BOX 188
LORTON, VA 22079-0188
04.13-8044 (JSC)
HELEN PIERIDES: 703-550-8044
NEW FABRICATION METHODS FOR DIMENSIONALLY STABLE GRAPHITE/MAGNESIUM SPACE STRUCTURES

CENTER FOR REMOTE SENSING
PO BOX 9244
MCLEAN, VA 22102
08.14-0800 (JPL)
SUMAN GANGULY: 703-848-0800
IMPROVED ANTENNA FOR SYNTHETIC APERTURE RADAR CALIBRATOR

REI SYSTEMS
PO BOX 9183
MCLEAN, VA 22102-0183
07.08-1745 (GSFC)
VEER V. BHARTIYA: 703-281-1745
A DISTRIBUTED OBJECT TYPE MANAGEMENT SYSTEM FOR HETEROGENEOUS ENVIRONMENTS

DIGITAL SIGNAL CORP
8003 FORBES PLACE
SPRINGFIELD, VA 22151
05.01-9200 (LaRC)
RICHARD L. SEBASTIAN: 703-321-9200
WAVELENGTH DIPLEXED, FIBER COUPLED, COHERENT LASER RADAR MEASUREMENT SYSTEM

INTERFEROMETRICS INC
8150 LEESBURG PIKE SUITE 1400
VIENNA, VA 22182
08.17-8500 (JPL)
DINO A. LORENZINI: 703-790-8500
DUAL K AND C BAND TRANSPONDER FOR SATELLITE ALTIMETRIC CALIBRATION

AURORA FLIGHT SCIENCES CORP
BOX 11998
ALEXANDRIA, VA 22312
03.08-5694 (ARC)
JOHN S. LANGFORD: 703-845-5694
FUEL CELL PROPULSION SYSTEM FOR A HIGH ALTITUDE RESEARCH PLATFORM

AUTOMETRIC INC
5301 SHAWNEE ROAD
ALEXANDRIA, VA 22312-2312
07.04-4000 (SSC)
WILLIAM A. BURK: 703-658-4000
IMPROVED ACCESSING OF DIGITAL DATA BASES BY GEOGRAPHIC INFORMATION SYSTEMS

ADVANCED TECHNOLOGIES INC
812 MIDDLE GROUND BLVD
NEWPORT NEWS, VA 23606
02.07-3017A (ARC)
C.H. PARKINSON: 804-873-3017
SOFT HUB FOR BEARINGLESS ROTORS

ANALYTICAL SERVICES & MATERIALS INC
107 RESEARCH DRIVE
HAMPTON, VA 23666
03.05-7093 (ARC)
DR. J. UNNAM: 804-865-7093
FLIGHT INSTRUMENTATION FOR SIMULTANEOUS DETECTION OF FLOW SEPARATION & TRANSITION

INFORMATION & CONTROL SYSTEM INC
28 RESEARCH DRIVE
HAMPTON, VA 23666
02.08-0371 (LaRC)
NESIM HALYO: 804-865-0371
A HIGH-TEMPERATURE DIRECTIONAL SPECTRAL EMISSIVITY MEASUREMENT SYSTEM

AMERICAN RESEARCH CORP OF VIRGINIA
PO BOX 3406
RADFORD, VA 24143-3406
03.06-0655 (ARC)
MRS. ANNE CHURCHILL: 703-731-0655
LASER SPECKLE INTERFEROMETER FOR SURFACE ACOUSTIC DISPLACEMENT MEASUREMENTS

AMERICAN RESEARCH CORP OF VIRGINIA
PO BOX 3406
RADFORD, VA 24143-3406
02.08-0655 (LaRC)
MRS. ANNE CHURCHILL: 703-731-0655
CROSS-CORRELATION OPTICAL STRAIN SENSOR FOR WIND TUNNEL TEST INSTRUMENTATION

WASHINGTON

AMTEC ENGINEERING INC
3055 112TH AVENUE NE, SUITE 208
BELLEVUE, WA 98004
02.01-3304 (MSFC)
KELTON M. PEERY: 206-827-3304
COUPLING GRID ADAPTION TO AN IMPLICIT NAVIER-STOKES SOLUTION PROCEDURE

ELECTROIMPACT INC
2721 NE BLAKELEY ST
SEATTLE, WA 98105
03.01-2403 (LeRC)
SAM SMITH: 206-525-2403
EDDY CURRENT REPULSION DE-ICING STRIP

STODDARD-HAMILTON AIRCRAFT INC
18701 58TH AVE NE
ARLINGTON, WA 98223
03.02-8533 (LaRC)
TED E. SETZER: 206-435-8533
LIGHTNING PROTECTION TECHNOLOGY FOR SMALLER GENERAL AVIATION AIRCRAFT

STIRLING TECHNOLOGY CO
2952 GEORGE WASHINGTON WAY
RICHLAND, WA 99352
09.12-4000 (GSFC)
MAURICE A. WHITE: 509-375-4000
A HIGH EFFICIENCY, LOW VIBRATION, LONG LIFE, STIRLING CRYOGENIC PRE-COOLER

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400 MISSISSIPPI STREET
MORGANTOWN, WV 26505-6751
12.02-6706 (MSFC)
GEORGE D. CASE: 304-291-6706
THIN MEMBRANE SENSORS

WISCONSIN

BIOTRONICS TECHNOLOGIES INC
12020 WEST RIPLEY AVENUE
WAUWATOSA, WI 53226
12.12-7653 (KSC)
CHARLES G. TERRIZZI: 414-475-7653
FIBER FLUOROMETRY FOR ON-LINE CHEMICAL ANALYSIS OF NUTRIENT SOLUTIONS

September 26, 1989
National Aeronautics and Space Administration
Small Business Innovation Research (SBIR) Proposals
Selected for Negotiation of SBIR Phase I Contracts
Sorted by Field Center, State

NASA AMES RESEARCH CENTER

DEMOGRAFX
10720 HEPBURN CIRCLE
CULVER CITY, CA 90232
06.06-2985 (ARC)
GARY DEMOS: 213-837-2985
APPLICATION OF HIGH PERFORMANCE DIGITAL VIDEO TO COMPUTER STORAGE

ACA INDUSTRIES INC
28603 TRAILRIDERS DRIVE
RANCHO PALOS VERDES, CA 90274
03.08-7121 (ARC)
JULIAN WOLKOVITCH: 213-539-7121
STUDY OF VERY-HIGH-ALTITUDE AIRCRAFT WITH JOINED WINGS

EIDETICS INTERNATIONAL INC
3415 LOMITA BOULEVARD
TORRANCE, CA 90505
02.06-8228A (ARC)
ANDREW M. SKOW: 213-326-8228
AERODYNAMIC CONTROL OF THE F/A-18 USING FOREBODY VORTEX BLOWING

SPEECH SYSTEMS INC
18356 OXNARD STREET
TARZANA, CA 91356
06.04-0885 (ARC)
DAN O. COPSEY: 818-881-0885
SITE-SPECIFIC AIR TRAFFIC CONTROL TRAINING SIMULATOR WITH SPEECH INPUT & OUTPUT

ISX CORP
501 MARIN STREET, SUITE 214
THOUSAND OAKS, CA 91360
06.04-8265 (ARC)
ROBERT A. BASSETT: 805-495-8265
KNOWLEDGE BASED AEROSPACE PROGRAM MANAGEMENT DECISION SUPPORT SYSTEM

G & C SYSTEMS INC
25176 DANAPEPPER
DANA POINT, CA 92629
03.10-0753 (ARC)
MARIJOSE GOMEZ TARTT: 714-661-0753
A KNOWLEDGE BASED SIMULATION DESIGN, DEVELOPMENT AND CODING ENVIRONMENT

METROLASER
18006 SKYPARK CIRCLE, SUITE 108
IRVINE, CA 92714-6428
02.04-0688A (ARC)
CECIL F. HESS: 714-553-0688
A HOLOGRAPHIC INTERFEROMETER SPECTROMETER FOR HYPERSONIC FLOW

MICROWAVE MONOLITHICS INC
465 EAST EASY STREET, UNIT F
SIMI VALLEY, CA 93065
06.06-6642 (ARC)
DANIEL R. CH'EN: 805-584-6642
ADVANCED OPTICAL HEAD TECHNOLOGY

ADVANCED RESEARCH AND APP. CORP
425 LAKESIDE DRIVE
SUNNYVALE, CA 94086
08.10-7780 (ARC)
MICHAEL J. BOYLE: 408-733-7780
MINIATURE BIOGENIC ELEMENT ANALYZER

FOOD AND AGROSYSTEMS INC
PO BOX 62185
SUNNYVALE, CA 94088
12.04-8450B (ARC)
THOMAS R. PARKS: 408-245-8450
METHODOLOGIES FOR PROCESSING PLANT MATERIALS INTO ACCEPTABLE FOOD ON A SMALL SCALE

JOHNSON AERONAUTICS
PO BOX 1253
PALO ALTO, CA 94302
02.07-3944 (ARC)
WAYNE JOHNSON: 415-325-3944
GENERAL TIME-DOMAIN UNSTEADY AERODYNAMICS OF ROTORS

DEACON RESEARCH
900 WELCH ROAD, SUITE 203
PALO ALTO, CA 94304
02.04-1520 (ARC)
OLIVE LEE: 415-326-1520
REMOTE MEASUREMENT SYSTEM FOR ARC JET TEMPERATURE AND DENSITY

APPLIED AND THEORETICAL MECHANICS INC
4501 SEQUOYAH ROAD
OAKLAND, CA 94605
02.01-1427 (ARC)
DR. JOELLE M. CHAMPNEY: 415-635-1427
TWO EQUATION TURBULENCE MODELING OF HYPERSONIC TRANSITIONAL FLOWS WITH UPS CODE

MATERIALS TECHNOLOGIES CORP
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MONROE, CT 06468
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LARRY LOOMIS: 301-992-9357
DEVICE FOR SAMPLE COLLECTION AND RAPID IMMUNOLOGICAL IDENTIFICATION OF BIOLOGICAL SPECIMENS

APA OPTICS INC
2950 N.E. 84TH LANE
BLAINE, MN 55434
09.09-4995 (JSC)
A.K. JAIN: 612-784-4995
FLAT PANEL MULTICOLOR DISPLAY BASED ON INTEGRATED OPTIC SCANNER

ROCKY RESEARCH
PO BOX 1086
BOULDER CITY, NV 89005
09.11-0851A (JSC)
UWE ROCKENFELLER: 702-293-0851
HIGH-DENSITY, CHEMICAL THERMAL STORAGE SYSTEM FOR LOW GRAVITY ENVIRONMENTS

SCS TELECOM INC
107 HAVEN AVENUE
PORT WASHINGTON, NY 11050
09.04-0760 (JSC)
DR. DONALD L. SCHILLING: 516-883-0760
A NOVEL DIRECTION-FINDING TECHNOLOGY FOR ROBOTIC TRACKING IN THE SPACE STATION

SCS TELECOM INC
107 HAVEN AVENUE
PORT WASHINGTON, NY 11050
14.01-0760A (JSC)
DR. DONALD L. SCHILLING: 516-883-0760
POWER AND BAND WIDTH EFFICIENT DIGITAL COMMUNICATIONS

UMPQUA RESEARCH COMPANY
PO BOX 791
MYRTLE CREEK, OR 97457
12.03-5201 (JSC)
GERALD V. COLOMBO: 503-863-5201
ELECTROCHEMICAL WATER RECOVERY PROCESS FOR DIRECT REMOVAL OF IMPURITIES

UMPQUA RESEARCH COMPANY
PO BOX 791
MYRTLE CREEK, OR 97457
12.08-5201 (JSC)
DAVID F. PUTNAM: 503-863-5201
THERMALLY DESORBABLE TOXIN AND ODOR CONTROL CARTRIDGE

BEND RESEARCH INC
64550 RESEARCH ROAD
BEND, OR 97701-8599
12.07-4100A (JSC)
ROD RAY: 503-382-4100
MEMBRANE-BASED HIGH-PRESSURE GAS-DEHYDRATION MODULE

CARNEGIE GROUP INC
FIVE PPG PLACE
PITTSBURGH, PA 15222
05.05-6900 (JSC)
DR. BRUCE RUSSELL: 412-642-6900
AN EXPERT ADVISOR FOR FAILURE MODE AND EFFECTS ANALYSIS GENERATION

EMEC CONSULTANTS
R.D. 3, ROUNDTOP ROAD
EXPORT, PA 15632
04.18-3260A (JSC)
RUDOLF KELLER: 412-325-3260
PRODUCTION OF OXYGEN BY ELECTROLYSIS OF LUNAR SOIL IN MOLTEN SALT

CHI SYSTEMS INC
GWYNEDD PLAZA III
SPRING HOUSE, PA 19477
12.05-1400 (JSC)
DR. FLOYD A. GLENN III: 215-542-1400
CAPTURNG SPACE CREW REPRESENTATIONS OF CONTROL SYSTEMS WITH MULTIDIMENSIONAL SCALING

LYNNTECH INC
ROUTE 5 BOX 946A
COLLEGE STATION, TX 77840
12.03-4131 (JSC)
WILLIAM B. CRAVEN: 409-846-4131
SOLID POLYMER ELECTROLYTE-BASED ELECTROLYZERS FOR WATER RECLAMATION POST-TREATMENT

IOMED INC
2320 S. 1290 W., SUITE A
SALT LAKE CITY, UT 84108
12.01-1191 (JSC)
STEVEN H. OBER: 801-975-1191
TRANSDERMAL DRUG DELIVERY SYSTEM FOR APPLICATION IN SPACE FLIGHT

SARCOS RESEARCH CORP
261 E. 300 S. SUITE 150
SALT LAKE CITY, UT 84111
12.07-0559A (JSC)
JOHN F. GRENNAN: 801-531-0559
USING ROBOTS IN THE TESTING OF NASA EVA SPACE SUITS

CORDEC CORP
8270-B CINDER BED ROAD -- P.O. BOX 188
LORTON, VA 22079-0188
04.13-8044 (JSC)
HELEN PIERIDES: 703-550-8044
NEW FABRICATION METHODS FOR DIMENSIONALLY STABLE GRAPHITE/MAGNESIUM SPACE STRUCTURES

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FEMTOMETRICS
1721 WHITTIER AVENUE, SUITE A
COSTA MESA, CA 92627
13.01-6239 (KSC)
MARGO BOWERS: 714-722-6239
A REAL TIME PARTICLE FALL-OUT MONITOR

TPL INC
100 VIA FLORENCE
NEWPORT BEACH, CA 92663
13.02-4256 (KSC)
NANCY E. STOLLER: 714-675-4256
A REPAIR COATING FOR CRYOGENIC TRANSFER LINES

OPHIR CORP
3190 S. WADSWORTH BLVD, SUITE 100
LAKEWOOD, CO 80227
13.03-1512 (KSC)
DONALD ROTTNER: 303-986-1512
A NOVEL LASER SYSTEM FOR FORECASTING AND MITIGATING LIGHTNING STRIKES

AEROSPACE DESIGN & DEVELOPMENT INC
PO BOX 672
NIWOT, CO 80544
13.04-2888 (KSC)
H.L. GIER: 303-530-2888
SUPERCRITICAL CRYOGENIC SELF-CONTAINED BREATHING APPARATUS

TRANSITIONS RESEARCH CORP
15 GREAT PASTURE ROAD
DANBURY, CT 06810
05.08-8988 (KSC)
J. F. ENGELBERGER: 203-798-8988
TORTUOUS-PATH ROBOT TRANSPORT

ENSCO INC
445 PINEDA COURT
MELBOURNE, FL 32940
13.03-4122 (KSC)
NORMAN BUSH: 703-321-9000
METEROLOGICAL MONITORING SYSTEM

AXIOMATICS CORP
60 ROGERS ST
CAMBRIDGE, MA 02142
12.12-6700 (KSC)
CRAIG R. DAVIS: 617-497-6700
REMOTE MOISTURE SENSOR TO CONTROL IRRIGATION OF PLANTS IN SPACE

GEO-CENTERS INC
7 WELLS AVENUE
NEWTON CENTRE, MA 02159
12.12-7070 (KSC)
EDWARD P. MARRAM: 617-964-7070
TRACE CONTAMINANT VAPOR MONITORS

FOSTER-MILLER INC
350 SECOND AVENUE
WALTHAM, MA 02254
05.08-3200 (KSC)
ADI R. GUZDAR: 617-890-3200
SELF-CONTAINED DEPLOYABLE SERPENTINE TRUSS FOR PRELAUNCH ACCESS OF ORBITER PAYLOADS

KENNEDY SPACE CENTER

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BRYN MAWR, PA 19010
12.14-5668A (KSC)
LON CROSBY, PH.D.: 215-527-4995
ANATOMICAL IMAGE ANALYSIS TECHNIQUES

BIOTRONICS TECHNOLOGIES INC
12020 WEST RIPLEY AVENUE
WAUWATOSA, WI 53226
12.12-7653 (KSC)
CHARLES G. TERRIZZI: 414-475-7653
FIBER FLUOROMETRY FOR ON-LINE CHEMICAL ANALYSIS OF NUTRIENT SOLUTIONS

LANGLEY RESEARCH CENTER

EIDETICS INTERNATIONAL INC
3415 LOMITA BOULEVARD
TORRANCE, CA 90505
03.03-8228A (LaRC)
ANDREW M. SKOW: 213-326-8228
AN IMPROVED METHODOLOGY TO ASSESS DEPARTURE SUSCEPTIBILITY VS. AGILITY

REFRACTORY COMPOSITES INC
12220-A RIVERA ROAD
WHITTIER, CA 90606
03.07-8061 (LaRC)
JOHN J. GALLOGLY: 213-698-8061
CERAMIC MATRIX COMPOSITE HYPERSONIC ENGINE STRUCTURES

SPACEBORNE INC
742 FOOTHILL BLVD SUITE 2B
LA CANADA, CA 91011
09.02-0126 (LaRC)
CONSTANTIN TIMOC: 818-952-0126
A HIGH-SPEED, FAULT-TOLERANT MICROPROCESSOR FOR SPACE APPLICATIONS

AMERICAN INNOVISION INC
7750 DAGGET ST SUITE 210
SAN DIEGO, CA 92111
05.01-9355 (LaRC)
ALAN J. GRANT: 619-560-9355
IDENTIFYING, LOCATING AND TRACKING OBJECTS BY DETECTING PRE-AFFIXED COLORED TARGETS

NIELSEN ENGINEERING & RESEARCH INC
510 CLYDE AVENUE
MOUNTAIN VIEW, CA 94043-2287
02.04-9457 (LaRC)
DAVID NIXON: 415-968-9457
A MODEL FOR SHOCK TURBULENCE INTERACTION

INTEGRATED SYSTEMS INC
2500 MISSION COLLEGE BOULEVARD
SANTA CLARA, CA 95054-1215
09.01-1500 (LaRC)
MICHAEL G. LYONS: 408-980-1500
CONTROL STRUCTURE INTERACTION: OPTIMIZATION BASED DESIGN TOOLS

GALLOWAY RESEARCH
795 BEAVER CREEK WAY
SAN JOSE, CA 95133
06.01-2490 (LaRC)
JOHN R. GALLOWAY, JR.: 408-259-2490
THE LAFS KERNEL FILE SYSTEM

COLORADO RESEARCH DEVELOPMENT CORP
621 17TH STREET, SUITE 1620
DENVER, CO 80293-1601
06.01-8633 (LaRC)
JACK E. DEETER: 303-293-8633
PARALLEL MULTILEVEL ADAPTIVE METHODS FOR FLOWS IN TRANSITION

SCHWARTZ ELECTRO-OPTICS INC
3404 N. ORANGE BLOSSOM TRAIL
ORLANDO, FL 32804
08.04-1802 (LaRC)
E. ADAMKIEWICZ: 407-298-1802
NOVEL COBALT-DOPED MAGNESIUM FLUORIDE LIDAR FOR AEROSOL PROFILER

SEARCH TECHNOLOGY INC
4725 PEACHTREE CORNERS CIRCLE, SUITE 200
NORCROSS, GA 30092
03.09-1457B (LaRC)
RUSTON M. HUNT: 404-441-1457
METHODS AND TOOLS FOR ASSESSING LIMITS OF SYSTEM INTELLIGENCE

SPIRE CORP
PATRIOTS PARK
BEDFORD, MA 01730
10.04-6000 (LaRC)
RICHARD GREGORIO: 617-275-6000
VERTICAL, MULTIJUNCTION, PHOTOVOLTAIC CELLS WITH BURIED SILICIDE INTERCONNECTIONS

SPIRE CORP
PATRIOTS PARK
BEDFORD, MA 01730
08.07-6000A (LaRC)
RICHARD S. GREGORIO: 617-275-6000
DEVELOPMENT OF 780NM AND 792 DIODE LASER PUMPS FOR SOLID STATE LASERS

SCHWARTZ ELECTRO-OPTICS INC
45 WINTHROP STREET
CONCORD, MA 01742
08.07-2299 (LaRC)
PETER F. MOULTON: 508-371-2299
LASERS OPTIMIZED FOR PUMPING TITANIUM-ALUMINA LASERS

ATLANTIC APPLIED RESEARCH CORP
4 A STREET
BURLINGTON, MA 01803
02.02-0559 (LaRC)
ROBERT [illegible] CARVER: 617-273-2400
WIND TUNNEL NOISE REDUCTION

CHARLES RIVER ANALYTICS INC
55 WHEELER STREET
CAMBRIDGE, MA 02138
09.02-3474 (LaRC)
ALPER K. CAGLAYAN: 617-491-3474
A NEURAL NET APPROACH TO SPACE VEHICLE GUIDANCE

NEKTONICS INC
400 FIFTH AVENUE
WALTHAM, MA 02154
02.03-5750 (LaRC)
ANTHONY T. PATERA: 617-290-5750
TRANSITION TO TURBULENCE IN COMPLEX AERODYNAMIC FLOWS

RADIATION MONITORING DEVICES INC
44 HUNT STREET
WATERTOWN, MA 02172
04.17-1167 (LaRC)
GERALD ENTINE: 617-926-1167
HIGH FIELD, HIGH Tc SUPERCONDUCTING MAGNETS

FOSTER-MILLER INC
350 SECOND AVENUE
WALTHAM, MA 02254
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ADI R. GUZDAR: 617-890-3200
LARC-TPI/LIQUID CRYSTAL POLYMER BLENDS

CREARE INC
PO BOX 71, ETNA ROAD
HANOVER, NH 03755
02.01-3800 (LaRC)
JAMES A. BLOCK: 603-643-3800
ADVANCED MODELING OF COMBUSTION SYSTEMS

CREARE INC
PO BOX 71, ETNA ROAD
HANOVER, NH 03755
15.03-3800 (LaRC)
DR. JAMES A. BLOCK: 603-643-3800
NUMERICAL MODELING OF PARTICLE FORMATION AND GROWTH DURING CHEMICAL VAPOR DEPOSITION

EPITAXX INC
3490 US ROUTE ONE
PRINCETON, NJ 08540
07.06-1188 (LaRC)
DR. GREGORY H. OLSEN: 609-452-1188
VISIBLE SEMICONDUCTOR DIODE LASERS GROWN BY HYDRIDE VAPOR PHASE EPITAXY

CONTINUUM DYNAMICS INC
PO BOX 3073
PRINCETON, NJ 08543
02.09-9282 (LaRC)
BARBARA A. HAWK: 609-734-9282
GENERAL FLOW FIELD ANALYSIS METHODS FOR HELICOPTER ROTOR AEROACOUSTICS

HIGH TECHNOLOGY SERVICES INC
250 JORDAN RD SUITE 210
TROY, NY 12180
04.03-8072 (LaRC)
MILTON L. EVANS: 518-283-8072
METHODS FOR PRODUCING FINE PARTICLE THERMOPLASTIC POLYIMIDE SULFONE POWDER

ODYSSEY RESEARCH ASSOCIATES
301A HARRIS B. DATES DRIVE
ITHACA, NY 14850
06.03-2020 (LaRC)
KENNETH R. MORIN: 607-277-2020
FORMAL VERIFICATION FOR C WITH UNIX

INNOVATIVE DYNAMICS
CORNELL RESEARCH PARK, 244 LANGMUIR LABS
ITHACA, NY 14850-1296.
04.06-0533 (LaRC)
JOSEPH J. GERARDI: 607-257-0533
AIRCRAFT HEALTH MONITORING SYSTEM

INNOVATIVE DYNAMICS
CORNELL RESEARCH PARK, 244 LANGMUIR LABS
ITHACA, NY 14850-1296
03.06-0533 (LaRC)
GAIL A. HICKMAN: 607-257-0534
LOW COST ANGLE-OF-ATTACK SENSOR FOR SUBSONIC AIRCRAFT

RIBBON TECHNOLOGY CORP
PO BOX 30758, 825 TAYLOR STATION ROAD
GAHANNA, OH 43230
04.09-5444 (LaRC)
LLOYD HACKMAN: 614-864-5444
PROCESS CONTROL FOR MELT OVERFLOW RAPID SOLIDIFICATION TECHNOLOGY

HANSEN RESEARCH ASSOCIATES
PO BOX 30133
EUGENE, OR 97403
02.04-4007 (LaRC)
C. FREDERICK HANSEN: 503-344-4007
TRANSPORT PROPERTIES IN NON-EQUILIBRIUM AIR MIXTURES

TEXTILE TECHNOLOGIES INC
2800 TURNPIKE DR
HATBORO, PA 19040
04.03-5325 (LaRC)
STEPHEN P. ZAWISLAK: 215-443-5325
MULTI-ANGULAR WEAVING FOR COMPOSITE PREFORMS

SYSTEMS & PROCESSES ENGINEERING CORP
1406 SMITH ROAD SUITE A
AUSTIN, TX 78721
04.06-0318 (LaRC)
CLAYTON A.T. NYBERG: 512-385-0318
DIGITAL OPTICAL PHASE-LOCK-LOOP FOR NON-DESTRUCTIVE EVALUATION

DIGITAL SIGNAL CORP
8003 FORBES PLACE
SPRINGFIELD, VA 22151
05.01-9200 (LaRC)
RICHARD L. SEBASTIAN: 703-321-9200
WAVELENGTH DIPLEXED, FIBER COUPLED, COHERENT LASER RADAR MEASUREMENT SYSTEM

INFORMATION & CONTROL SYSTEM INC
28 RESEARCH DRIVE
HAMPTON, VA 23666
02.08-0371 (LaRC)
NESIM HALYO: 804-865-0371
A HIGH-TEMPERATURE DIRECTIONAL SPECTRAL EMISSIVITY MEASUREMENT SYSTEM

AMERICAN RESEARCH CORP OF VIRGINIA
PO BOX 3406
RADFORD, VA 24143-3406
02.08-0655 (LaRC)
MRS. ANNE CHURCHILL: 703-731-0655
CROSS-CORRELATION OPTICAL STRAIN SENSOR FOR WIND TUNNEL TEST INSTRUMENTATION

STODDARD-HAMILTON AIRCRAFT INC
18701 58TH AVE NE
ARLINGTON, WA 98223
03.02-8533 (LaRC)
TED E. SETZER: 206-435-8533
LIGHTNING PROTECTION TECHNOLOGY FOR SMALLER GENERAL AVIATION AIRCRAFT

LEWIS RESEARCH CENTER

CFD RESEARCH CORP
3313 BOB WALLACE AVENUE SUITE 205
HUNTSVILLE, AL 35805
01.02-6576 (LeRC)
ASHOK K. SINGHAL: 205-536-6576
RAPID MIX CONCEPTS FOR LOW EMISSION COMBUSTORS IN GAS TURBINE ENGINES

MATERIALS AND ELECTROCHEMICAL RESEARCH
7960 S. KOLB ROAD
TUCSON, AZ 85706
04.01-1980A (LeRC)
R.O. LOUTFY: 602-574-1980
A COATED, TITANIUM BORIDE, WHISKER-TOUGHENED SILICON CARBIDE MATRIX COMPOSITE

ULTRAMET
12173 MONTAGUE STREET
PACOIMA, CA 91331
04.04-0236 (LeRC)
ROBERT H. TUFFIAS, PH.D.: 818-899-0236
CVD CHROMIUM DIBORIDE FIBERS FOR METAL MATRIX COMPOSITES

DELTA G CORP
9960-A GLENOAKS BLVD
SUN VALLEY, CA 91352
01.03-4888 (LeRC)
ROBERT A. HOLZL: 818-767-4000
HIGH TEMPERATURE HOSTILE ENVIRONMENT INSTRUMENTS MANUFACTURED BY CVD

LINEAR MONOLITHICS INC
660 HAMPSHIRE ROAD SUITE 212
WESTLAKE VILLAGE, CA 91361
14.07-3011 (LeRC)
FRED A. BLUM: 805-494-3011
FEEDBACK PSEUDOMORPHIC HEMT LOW NOISE AMPLIFIERS FOR LOW COST RECEIVERS

ELECTROFORMED NICKEL INC
283 WINFIELD CIRCLE
CORONA, CA 91720
11.01-4707 (LeRC)
RICH EDWARDS: 714-371-4704
HIGH TEMPERATURE OXIDATION BARRIER COATINGS FOR REFRACTORY METALS

ADVANCED ENERGY TECHNOLOGY INC
16966 CLOUDCROFT DRIVE
POWAY, CA 92064
10.01-4310 (LeRC)
GARY O. FITZPATRICK: 619-455-4310
NEW THERMIONIC CONVERTER FOR OUT-OF-CORE SPACE POWER SYSTEM

ENERGY SCIENCE LABORATORIES INC
10955 JOHN J. HOPKINS DRIVE
SAN DIEGO, CA 92121
10.01-4688 (LeRC)
JAMES R. CLINTON: 619-455-4688
COMPOSITE REGENERATOR FOR STIRLING ENGINE

ISG ASSOCIATES INC
5130 E. LA PALMA AVE #206
ANAHEIM HILLS, CA 92807
01.02-9888 (LeRC)
R.G. BUSCHER: 714-779-9888
INFLUENCE OF TOOTH PROFILE MODIFICATION ON THE LUBRICATION OF INVOLUTE GEARING

AEROMETRICS INC
894 ROSS DRIVE, UNIT 105
SUNNYVALE, CA 94089
11.01-0321A (LeRC)
DR. W.D. BACHALO: 408-745-0321
SIMULTANEOUS MEASUREMENT OF TEMPERATURE, SIZE, AND VELOCITY OF DROPS IN SPRAYS

CSA ENGINEERING INC
560 SAN ANTONIO ROAD, SUITE 101
PALO ALTO, CA 94306-4682
04.05-7351 (LeRC)
DR. CONOR D. JOHNSON: 415-494-7351
DEVELOPMENT OF ADVANCED FINITE ELEMENTS FOR STRUCTURAL ANALYSIS

MOLLER INTERNATIONAL INC
1222 RESEARCH PARK DRIVE
DAVIS, CA 95616
01.02-5086 (LeRC)
PAUL S. MOLLER: 916-756-5086
EVALUATION OF PS200 COATING AS A THERMAL BARRIER IN AN AIR-COOLED ROTARY ENGINE

UNIQUE MOBILITY INC
3700 SOUTH JASON ST
ENGLEWOOD, CO 80110
05.07-2137 (LeRC)
JOHN S. GOULD: 303-761-2137
ROBOTIC ACTUATOR OPTIMIZATION

HYDROGEN CONSULTANTS INC
12420 N. DUMONT WAY
LITTLETON, CO 80125
10.01-7972 (LeRC)
GREGORY J. EGAN: 303-791-7972
CONSTANT TEMPERATURE HEAT STORAGE IN METAL HYDRIDES

SCIENTIFIC RESEARCH ASSOCIATES INC
PO BOX 1058, 50 NYE ROAD
GLASTONBURY, CT 06033
01.01-0333B (LeRC)
DR. STEPHEN J. SHAMROTH: 203-659-0333
FLOW IN TURBINE BLADE PASSAGES

ADVANCED TECHNOLOGY MATERIALS INC
520-B DANBURY ROAD
NEW MILFORD, CT 06776
04.17-2681 (LeRC)
E. G. BANUCCI: 203-355-2681
NOVEL PROCESS FOR THE THIN FILM GROWTH OF YTTRIUM-BARIUM-CUPRATE

IOWA THIN FILM TECHNOLOGIES INC
237 WILDFLOWER DRIVE
AMES, IA 50010
10.01-3203 (LeRC)
DERRICK GRIMMER: 515-294-7732
FLEXIBLE, LIGHTWEIGHT AMORPHOUS SILICON SOLAR CELLS TUNED FOR AMO SPECTRUM

ACCEL CATALYSIS INC
TECHNOLOGY INNOVATION CENTER, UV OF IOWA
IOWA CITY, IA 52242
11.01-4577 (LeRC)
DARRELL P. EYMAN: 319-335-1359
A CATALYTIC THERMAL MANAGEMENT SYSTEM FOR HYDROGEN-FUELED INJECTION VEHICLES

SPIRE CORP
PATRIOTS PARK
BEDFORD, MA 01730
14.05-6000A (LeRC)
RICHARD GREGORIO: 617-275-6000
HIGH-INDIUM-CONTENT HIGH ELECTRON MOBILITY TRANSISTORS FOR RF COMMUNICATIONS DEVICES

SCHWARTZ ELECTRO-OPTICS INC
45 WINTHROP STREET
CONCORD, MA 01742
15.02-2299 (LeRC)
PETER F. MOULTON: 508-371-2299
SPACE-QUALIFIED LASER FOR MICROGRAVITY EXPERIMENTS

CPS SUPERCONDUCTOR CORP
155 FORTUNE BOULEVARD
MILFORD, MA 01757
04.17-3422A (LeRC)
CHARLES N. MCCORMACK: 508-634-3422
ULTRARAPID TEXTURED GROWTH OF YTTRIUM-BARIUM-CUPRATE FILAMENTS FOR COMPOSITE HTSC WIRE

PHYSICAL SCIENCES INC
PO BOX 3100, RESEARCH PARK
ANDOVER, MA 01810-7100
01.01-9030A (LeRC)
B. DAVID GREEN: 508-475-9030
REACTION MECHANICS AND KINETIC RATES FOR SOOT FORMATION

PHYSICAL SCIENCES INC
PO BOX 3100, RESEARCH PARK
ANDOVER, MA 01810-7100
01.03-9030 (LeRC)
B. DAVID GREEN: 508-475-9030
LASER-INDUCED FLUORESCENCE MEASUREMENTS OF VELOCITY IN SUPERSONIC REACTING FLOWFIELDS

PANAMETRICS INC
221 CRESCENT STREET
WALTHAM, MA 02254
08.22-2719 (LeRC)
CHARLES H. HOGAN: 617-899-2719
CRYOGENIC ULTRASONIC MASS FLOWMETER AND QUALITY METER

FOSTER-MILLER INC
350 SECOND AVENUE
WALTHAM, MA 02254
04.01-3200 (LeRC)
ADI R. GUZDAR: 617-890-3200
HIGH-TEMPERATURE-FILM BASED POLYBENZOXAZOLE/POLYMIDE MICROCOMPOSITE FOR TURBINE ENGINES

FOA ENGINEERING
3404 THORNAPPLE ST.
CHEVY CHASE, MD 20815
01.04-2685 (LeRC)
JOSEPH V. FOA: 301-656-2685
HIGH-EFFICIENCY FLOW INDUCTION

BRIMROSE CORPORATION OF AMERICA
5020 CAMPBELL BOULEVARD, BLDG 1
BALTIMORE, MD 21236
15.02-5800 (LeRC)
DR. R. G. ROSEMEIER: 301-529-5800
NOVEL 'IN SITU' TECHNIQUE TO VISUALIZE CONVECTION ON SOLID-LIQUID INTERFACES

APPLIED RESEARCH ASSOCIATES INC
6404 FALLS OF NEUSE ROAD SUITE 200
RALEIGH, NC 27615
04.02-0018 (LeRC)
LAWRENCE A. TWISDALE: 919-876-0018
PROBABILISTIC STRUCTURAL MECHANICS RESEARCH FOR PARALLEL PROCESSING COMPUTERS

AEROCHEM RESEARCH LABORATORIES INC
PO BOX 12
PRINCETON, NJ 08542
02.10-7070 (LeRC)
HARTWELL F. CALCOTE: 609-921-7070
COMPUTER SIMULATION AND DESIGN OF JET NOISE SUPPRESSORS

TEKNOWLOGICA INC
PO BOX 145
PRINCETON JUNCTION, NJ 08550
01.03-9654A (LeRC)
ROBERT W. MCCULLOUGH: 609-799-9654
NON-INTRUSIVE SINGLE POINT PRESSURE/TEMPERATURE SENSOR FOR AERONAUTICAL PROPULSION APPLICATIONS

CUMBS ASSOCIATES INC
11 HARTS LANE
EAST BRUNSWICK, NJ 08816
04.01-9049 (LeRC)
RONALD W. CUMBS: 201-257-9049
SOLUBLE CONDUCTING POLYMER-BASED CONDUCTIVE COATINGS

NEOCERA ASSOCIATES INC
PO BOX 815
PISCATAWAY, NJ 08855
04.17-2694 (LeRC)
ROGER EDWARDS: 201-647-2694
MICROWAVE-COMPATIBLE HIGH-Tc SUPERCONDUCTING FILMS ON SAPPHIRE SUBSTRATES

SOUTHWEST SCIENCES INC
1570 PACHECO STREET, SUITE E-11
SANTA FE, NM 87501
15.02-1322 (LeRC)
ALAN C. STANTON: 505-984-1322
COMBUSTION DIAGNOSTICS FOR MICROGRAVITY RESEARCH USING NEAR-INFRARED DIODE LASERS

LEWIS RESEARCH CENTER

PROGRAM DEVELOPMENT CORP OF SCARSDALE
300 HAMILTON AVE SUITE 409
WHITE PLAINS, NY 10601
01.01-1732A (LeRC)
PETER R. EISEMAN: 914-761-1732
TURBO: A GRID GENERATION CODE WITH AUTOMATIC ZONING

RIBBON TECHNOLOGY CORP
PO BOX 30758, 825 TAYLOR STATION ROAD
GAHANNA, OH 43230
04.04-5444A (LeRC)
LLOYD HACKMAN: 614-864-5444
RAPIDLY SOLIDIFIED NARROW TITANIUM ALUMINIDE STRIP

CORDEC CORP
8270-B CINDER BED ROAD -- P.O. BOX 188
LORTON, VA 22079-0188
04.04-8044 (LeRC)
HELEN PIERIDES: 703-550-8044
MICROSTRUCTURALLY TOUGHENED INTERMETALLIC MATRIX COMPOSITES

ELECTROIMPACT INC
2721 NE BLAKELEY ST
SEATTLE, WA 98105
03.01-2403 (LeRC)
SAM SMITH: 206-525-2403
EDDY CURRENT REPULSION DE-ICING STRIP

MARSHALL SPACE FLIGHT CENTER

MICROGRAVITY SYSTEMS INC
4215 AL 72E
BROWNSBORO, AL 35741
15.01-2043 (MSFC)
BILLY R. ALDRICH: 205-776-2043
PERMANENT MAGNET FLIGHT FURNACE

JOHN M. COCKERHAM & ASSOCIATES INC
301 RANDOLPH AVENUE SE
HUNTSVILLE, AL 35801
04.08-6381 (MSFC)
JACK E. SIMON: 205-536-6381
PORTABLE SPECTROREFLECTOMETER

ENGINEERING ANALYSIS INC
715 ARCADIA CIRCLE
HUNTSVILLE, AL 35801-5909
02.09-9391 (MSFC)
FRANK B. TATOM: 205-533-9391
THE APPLICATIONS OF FRACTIONAL CALCULUS TO NOISE SIMULATION

ENGINEERING ANALYSIS INC
715 ARCADIA CIRCLE
HUNTSVILLE, AL 35801-5909
02.03-9391 (MSFC)
FRANK B. TATOM: 205-533-9391
CALCULATION OF SURFACE PRESSURE FLUCTUATIONS BASED ON TIME-AVERAGED TURBULENT FLOW COMPUTATIONS

ALABAMA CRYOGENIC ENGINEERING INC
PO BOX 2470
HUNTSVILLE, AL 35804
11.03-8629C (MSFC)
MARY T. HENDRICKS: 205-536-8629
ORTHO-PARA CONVERSION IN SPACE-BASED HYDROGEN DEWAR SYSTEMS

HUNTSVILLE SCIENCES CORP
3313 BOB WALLACE AVENUE SUITE 201
HUNTSVILLE, AL 35805
09.13-8122 (MSFC)
LAWRENCE W. SPARDLEY: 205-536-8122
FINITE-ELEMENT/ADAPTIVE GRID THERMAL ANALYZER WITH ENHANCED GRAPHICS CAPABILITY

REMTECH INC
3304 WESTMILL DRIVE
HUNTSVILLE, AL 35805
09.14-8561 (MSFC)
CHARLES E. FULLER: 205-536-8581
INTEGRATED CAD VENTING ANALYSIS PACKAGE

CFD RESEARCH CORP
3313 BOB WALLACE AVENUE SUITE 205
HUNTSVILLE, AL 35805
04.10-6576 (MSFC)
DR. ASHOK K. SINGHAL: 205-536-6576
A MATHEMATICAL MODEL TO INVESTIGATE UNDERCUTTING AND TO OPTIMIZE WELD QUALITY

SECA INC
3311 BOB WALLACE AVENUE SUITE 203
HUNTSVILLE, AL 35805
11.02-2008 (MSFC)
DR. RICHARD C. FARMER: 205-534-2008
HEAT TRANSFER IN ROCKET ENGINE COMBUSTION CHAMBERS AND REGENERATIVELY COOLED NOZZLES

REMTECH INC
3304 WESTMILL DRIVE
HUNTSVILLE, AL 35805
02.05-8581 (MSFC)
CHARLES E. FULLER: 205-536-8581
COUPLING OF UNSTEADY FLUID DYNAMICS AND STRUCTURE IN LOW DENSITY HIGH SPEED FLOWS

PDA ENGINEERING
2975 REDHILL AVENUE
COSTA MESA, CA 92626
11.04-8900A (MSFC)
LYNN SHERIDAN: 714-540-8900
PHYSICALLY BASED FAILURE CRITERIA FOR CARBON-PHENOLIC MATERIALS

IRVINE SENSORS CORP
3001 REDHILL AVE BUILDING 3 SUITE 208
COSTA MESA, CA 92626
08.09-8211A (MSFC)
JOHN J. STUART, JR.: 714-549-8211
SPACE SENSOR COMMON MODULE ELECTRONICS

IMATRON INC
389 OYSTER PT. BOULEVARD
SOUTH SAN FRANCISCO, CA 94080
11.04-9964 (MSFC)
DOUGLAS P. BOYD: 415-583-9964
ASSESSMENT OF MATERIALS IN SOLID ROCKET MOTORS BY REAL-TIME CT

ELECTRO-OPTICS TECHNOLOGY INC
4057 CLIPPER COURT
FREMONT, CA 94538
08.08-4022 (MSFC)
KIM ROBERT MACK: 415-651-4022
MULTIPLE DIODE PUMPED Ho:Tm:YAG PLANAR RING LASER

ADA TECHNOLOGIES INC
304 INVERNESS WAY SOUTH, SUITE 480
ENGLEWOOD, CO 80112
12.02-5615 (MSFC)
JUDITH A. ARMSTRONG: 303-792-5615
INCIPIENT COMBUSTION MONITOR FOR ZERO GRAVITY ENVIRONMENTS

SCIENTIFIC RESEARCH ASSOCIATES INC
PO BOX 1058, 50 NYE ROAD
GLASTONBURY, CT 06033
11.02-0333 (MSFC)
STEPHEN J. SHAMROTH: 203-659-0333
AN EULERIAN-LAGRANGIAN ANALYSIS FOR LIQUID FLOWS WITH VAPOR BUBBLES

INTERSONICS INC
3453 COMMERICAL AVENUE
NORTHBROOK, IL 60062
15.01-1772 (MSFC)
DR. CHARLES A. REY: 312-272-1772
STABILIZED ELECTROMAGNETIC LEVITATOR

BIO-IMAGING RESEARCH INC
425 BARCLAY BOULEVARD
LINCOLNSHIRE, IL 60069
11.04-6425 (MSFC)
ELLEN M. SINGER: 312-634-6425
SLIT DIGITAL RADIOGRAPHY FOR ANALYSIS OF BOND DEFECTS IN ROCKET MOTORS

MARSHALL SPACE FLIGHT CENTER

MILLITECH CORP
PO BOX 109 SOUTH DEERFIELD RESEARCH PARK
SOUTH DEERFIELD, MA 01373
08.09-8551 (MSFC)
WILLIE S. DAY: 413-665-8551
A BROADBAND MULTICHANNEL PRECIPITATION SENSOR

CASTLE TECHNOLOGY CORP
262 WEST CUMMINGS PARK
WOBURN, MA 01801
04.17-5634 (MSFC)
J. PAUL PEMSLER: 617-933-5634
INCREASING CRITICAL CURRENT DENSITIES IN HIGH-Tc SUPERCONDUCTORS

TECH. INTEGRATION & DEVELOP. GROUP INC
ONE PROGRESS ROAD
BILLERICA, MA 01821
15.05-3779 (MSFC)
RICHARD E. HAYDEN: 508-667-3779
AUTOMATIC FAULT DETECTION AND FAILURE PREDICTION FOR SPACECRAFT SYSTEMS

AUTOMATIX INC
755 MIDDLESEX TURNPIKE
BILLERICA, MA 01821
04.10-7900 (MSFC)
DR. DONALD L. PIEPER: 508-667-7900
MACRO AND TASK-LEVEL PROGRAMMING OF ARC WELDING ROBOTS FOR AEROSPACE APPLICATIONS

CHEMICAL TESTING AND CONSULTING CO
64 PINCKNEY STREET, UNIT #3
BOSTON, MA 02114
12.09-0966 (MSFC)
SHARON CUNNINGHAM: 617-720-0966
CHEMICAL SENSOR SYSTEM FOR THE IDENTIFICATION OF ORGANIC COMPOUNDS IN WATER

SATCON TECHNOLOGY CORP
71 ROGERS STREET
CAMBRIDGE, MA 02142-1118
10.01-0540 (MSFC)
DAVID B. EISENHAURE: 617-661-0540
INTEGRATED POWER AND ATTITUDE CONTROL SYSTEM FOR THE SPACE STATION AND OTHER APPLICATIONS

SCIENCE RESEARCH LABORATORY INC
15 WARD STREET
SOMERVILLE, MA 02143
08.08-1122A (MSFC)
JONAH JACOB: 617-547-1122
COMPACT, LIGHTWEIGHT EXPANDING BEAM CO2 LASER AMPLIFIERS FOR SPACEBOARD APPLICATIONS

FOSTER-MILLER INC
350 SECOND AVENUE
WALTHAM, MA 02254
09.05-3200 (MSFC)
ADI R. GUZDAR: 617-890-3200
NOVEL COMPOSITES FOR PROTECTION AGAINST ORBITAL DEBRIS

CREARE INC
PO BOX 71, ETNA ROAD
HANOVER, NH 03755
09.13-3800 (MSFC)
JAMES A. BLOCK: 603-643-3800
CONDENSER COMPONENT DESIGN FOR ALKALI METAL THERMOELECTRIC CONVERSION SYSTEMS

ROCKY RESEARCH
PO BOX 1086
BOULDER CITY, NV 89005
09.13-0851A (MSFC)
UWE ROCKENFELLER: 702-293-0851
HIGH-LIFT, HEAT-ACTUATED, SOLID-VAPOR HEAT PUMP FOR SIMULTANEOUS REFRIGERATION AND WATER HEATING

UMPQUA RESEARCH COMPANY
PO BOX 791
MYRTLE CREEK, OR 97457
12.02-5201B (MSFC)
GERALD V. COLOMBO: 503-863-5201
A REAGENTLESS SEPARATOR FOR REMOVAL OF INORGANIC CARBON FROM SOLUTION

THERMACORE INC
780 EDEN ROAD
LANCASTER, PA 17601
09.13-6551 (MSFC)
RICHARD W. LONGSDERFF: 717-569-6551
COMPOSITE MATERIAL HEAT PIPE TECHNOLOGY

FWG ASSOCIATES INC
217 LAKEWOOD DRIVE
TULLAHOMA, TN 37388
13.03-1982 (MSFC)
DR. WALTER FROST: 615-455-1982
INSTRUMENTED ROCKET WIND PROFILER

ACCURATE AUTOMATION CORPORATION
SUITE A-180, 409 CHESTNUT STREET
CHATTANOOGA, TN 37402
05.09-5959A (MSFC)
ROBERT M. PAP: 615-267-5959
ADVANCED TELEROBOTIC CONCEPTS USING NEURAL NETWORKS

MICON ENGINEERING
ONE GRAHAM ROAD
COLLEGE STATION, TX 77840
10.06-8911 (MSFC)
R. PAGE HELLER: 409-690-8911
INTELLIGENT PROTECTION SYSTEM FOR SPACE POWER APPLICATIONS

COMPUTER ALGORITHM DEVELOPMENT
2806 A NUECES
AUSTIN, TX 78705
05.09-6511 (MSFC)
RONALD VANBEEK: 512-474-6511
ACTIVE DETECTION AND TRACKING SENSOR FOR PASSIVE TARGETS

AMTEC ENGINEERING INC
3055 112TH AVENUE NE, SUITE 208
BELLEVUE, WA 98004
02.01-3304 (MSFC)
KELTON M. PEERY: 206-827-3304
COUPLING GRID ADAPTION TO AN IMPLICIT NAVIER-STOKES SOLUTION PROCEDURE

RESOURCE TECHNOLOGIES GROUP INC
400 MISSISSIPPI STREET
MORGANTOWN, WV 26505-6751
12.02-6706 (MSFC)
GEORGE D. CASE: 304-291-6706
THIN MEMBRANE SENSORS

STENNIS SPACE CENTER

TERASTAR
3463 STATE STREET SUITE 285
SANTA BARBARA, CA 93105
07.04-0532 (SSC)
J.L. STAR: 805-685-1946
GEOGRAPHIC INFORMATION SYSTEMS AND LARGE SPATIAL DATABASES

TECHNOLOGY INTERNATIONAL INC
429 WEST AIRLINE HIGHWAY, SUITE S
LAPLACE, LA 70068
07.03-1127 (SSC)
ZEINAB A. SABRI: 504-652-1127
APPLICATION OF FRACTALS TO SMOOTHING OVER THE PARAMETER SPACE

PHOTON RESEARCH ASSOCIATES INC
1033 MASSACHUSETTS AVENUE
CAMBRIDGE, MA 02138
08.03-1522 (SSC)
DR. JAMES C. FRASER: 617-354-1522
MULTISPECTRAL REMOTE SENSING USING SPRITE TECHNOLOGY

SPATIAL INFORMATION SCIENCES INC
MISSISSIPPI TECH TRANSFER OFFICE
STENNIS SPACE CENTER, MS 34529
07.04-6685 (SSC)
J. FRANK HEBARD: 703-430-6685
RASTER AND VECTOR DATA INTEGRATION, INTERACTIVE EDIT AND ANALYSIS

AUTOMETRIC INC
5301 SHAWNEE ROAD
ALEXANDRIA, VA 22312-2312
07.04-4000 (SSC)
WILLIAM A. BURK: 703-658-4000
IMPROVED ACCESSING OF DIGITAL DATA BASES BY GEOGRAPHIC INFORMATION SYSTEMS

NASA News

National Aeronautics and
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Washington, D.C. 20546
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Stennis Space Center, Miss.
(Phone: 601/688-1413)

For Release:
11 a.m. EDT
September 26, 1989

RELEASE: 89-149

STUDY SHOWS COMMON PLANTS HELP REDUCE INDOOR AIR POLLUTION

Common indoor plants may provide a valuable weapon in the fight against rising levels of indoor air pollution, based on research conducted by NASA.

NASA and the Associated Landscape Contractors of America (ALCA) today announced the findings of a 2-year study that suggests the common indoor plant may provide a natural way of combating "sick building" syndrome -- an acute incidence of indoor air pollution that can occur in closed or poorly ventilated offices and residences.

Research into the use of biological processes, as a means of solving environmental problems both on Earth and in space habitats, has been carried out for many years by Dr. Bill Wolverton, a senior research scientist at NASA's John C. Stennis Space Center, Bay St. Louis, Miss.

Based on preliminary evaluations of the use of common indoor plants for indoor air purification and revitalization, ALCA joined NASA to fund a study of about a dozen popular varieties of ornamental plants to determine their effectiveness in removing several key pollutants associated with indoor air pollution.

-more-

While more research is needed, Wolverton says the study has shown that common landscaping plants can remove certain pollutants from the indoor environment. "We feel that future results will provide an even stronger argument that common landscaping plants can be a very effective part of a system used to provide pollution-free homes and work places," he concludes.

Each plant type was placed in sealed, plexiglass chambers in which chemicals were injected. Philodendron, spider plant and the golden pothos were labeled as the most effective in removing formaldehyde. Flowering plants such as the gerbera daisy and chrysanthemums were rated superior in removing benzene from the chamber atmosphere.

Other plants demonstrated to be effective air purifiers include the bamboo palm, peace lily, ficus, mass cane, mother-in-law's tongue, English ivy and Chinese evergreen.

"Plants take substances out of the air through the tiny openings in their leaves," Wolverton said. "But research in our laboratories has determined that plant leaves, roots and soil bacteria are all important in removing trace levels of toxic vapors."

"Combining nature with technology can increase the effectiveness of plants in removing air pollutants," he said. A living air cleaner is created by combining activated carbon and a fan with a potted plant. "The roots of the plant grow right into the carbon and slowly degrade the chemicals absorbed there," Wolverton explains.

- end -

NASA News

National Aeronautics and
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For Release:
2 P.M. EDT
September 28, 1989

RELEASE: 89-150

NASA SELECTS SMALL BUSINESS RESEARCH PROPOSALS

NASA announced today the selection of 248 research proposals for immediate negotiation of Phase I contracts in NASA's 1989 Small Business Innovation Research Program (SBIR). Proposals were selected from 198 small, high technology firms located in 35 states.

SBIR objectives are to stimulate technological innovation in the United States by using small business, including minority and disadvantaged firms, to help meet Federal research and development needs and to encourage commercial applications of Federally supported research innovations.

These SBIR awards were selected competitively from 2142 proposals received in response to the SBIR solicitation which closed June 28, 1989. Selections were made on the basis of scientific and technical merit, capabilities of the firm and value of the proposed research innovations to NASA. This is the 7th year of the NASA SBIR program, which is conducted in accordance with Public Law 97-219, the Small Business Innovation Development Act of 1982, as amended by Public Law 99-443.

Phase I projects are 6-month, fixed-price contract efforts, normally not exceeding $50,000, to establish the feasibility of innovative research concepts proposed by the contractor to meet agency needs or opportunities described in the SBIR program solicitation. The projects showing greatest promise are eligible for Phase II contracts to pursue concept development. Phase II contracts do not normally exceed 2-years in duration and $500,000 value. Approximately one-half the Phase I projects proceed into Phase II.

Phase III activities may be commercial development funded by the private sector or may be procurement or continued development for government use funded outside the SBIR program by NASA or other agencies.

- more -

As required by law, NASA allocates 1.25 percent of its annual research and development budget for SBIR. Approximately $12 million of NASA's 1990 SBIR budget will fund these 248 Phase I projects.

The program is managed by NASA's Office of Commercial Programs, NASA Headquarters, Washington, D.C., and all individual SBIR projects are managed by 9 NASA field centers.

- end general release -

EDITORS NOTE: A listing of companies selected for this program is available at NASA Headquarters (Phone: 202/453-8400) and all NASA field centers.

- more -

NASA 89-1 PHASE I AWARD DISTRIBUTIONS
September 26, 1989

STATE	AWARDS	FIRMS
Alabama	11	8
Arizona	4	2
California	61	53
Colorado	9	9
Connecticut	8	6
Florida	6	5
Georgia	2	2
Hawaii	1	1
Illinois	3	3
Indiana	1	1
Iowa	2	2
Kansas	1	1
Louisiana	1	1
Maryland	11	11
Massachusetts	47	31
Michigan	1	1
Minnesota	3	2
Montana	1	1
Nevada	2	1
New Hampshire	4	1
New Jersey	8	7
New Mexico	1	1
New York	9	7
North Carolina	1	1
Ohio	3	2
Oregon	5	3
Pennsylvania	8	7
Tennessee	2	2
Texas	9	8
Utah	3	2
Virginia	13	11
Washington	4	4
West Virginia	1	1
Wisconsin	1	1

- more -

AWARDS DISTRIBUTION BY NASA FIELD CENTER

NASA CENTER	AWARDS	FIRMS
Ames Research Center Moffett Field, CA	26	26
Goddard Space Flight Center Greenbelt, MD	37	37
Jet Propulsion Laboratory Pasadena, CA	25	23
Johnson Space Center Houston, TX	37	36
Kennedy Space Center Kennedy Space Center, FL	11	11
Langley Research Center Hampton, VA	34	33
Lewis Research Center Cleveland, OH	37	37
Marshall Space Flight Center MSFC, AL	36	36
Stennis Space Center Stennis Space Center, MS	5	5

- end -

NASA News

National Aeronautics and
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Washington, D.C. 20546
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For Release:
September 28, 1989

RELEASE: 89-152

NASA SCIENTISTS OBSERVE STRONG ANTARCTIC OZONE HOLE

Scientists at NASA's Goddard Space Flight Center, Greenbelt, Md., have observed the development of an ozone hole that may equal the record-setting hole of 1987.

Goddard scientists Dr. Arlin Krueger, Dr. Richard Stolarski and Dr. Mark Schoeberl have been closely monitoring ozone levels over the Southern Hemisphere with the Total Ozone Mapping Spectrometer (TOMS), an instrument on board NASA's NIMBUS-7 satellite.

Through mid-September, the ozone hole of 1989 was very similar to the strong ozone hole recorded in 1987. By Sept. 23, the minimum value of ozone over Antarctica had decreased by nearly 30 percent from the beginning of the month. In 1988, the minimum decreased by only 15 percent over the entire month of September.

During September, the minimum ozone value has been decreasing at nearly the same rate as in 1987, about 1.5 percent per day. In 1987, this decrease continued until Oct. 5, when a record low ozone level was reached. Krueger, the TOMS principal investigator, said, "The ultimate depth of this year's ozone hole will depend on how long the current rate of decrease is maintained."

- more -

The scientists reported that the Southern Hemisphere winter began with record low ozone amounts at mid- and sub-polar latitudes. In August, the polar vortex was extremely cold and undisturbed. According to current theory of the ozone hole, these are the ideal conditions for the formation of polar stratospheric clouds that lead to the ozone depletion.

The NIMBUS-7 TOMS instrument has been measuring stratospheric ozone for more than 10 years.

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NOTE TO EDITORS: Color photographs of the ozone hole are available by calling the Goddard public affairs office at 301-286-8957.

NASA News

National Aeronautics and
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For Release:
September 29, 1989

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RELEASE: 89-153

SECOND GROUP OF ASTRONAUT HOPEFULS TO ARRIVE AT JSC

The second of an expected five groups of astronaut applicants will arrive at the Johnson Space Center, Houston, for orientation, medical evaluations and interviews on Monday, October 2. Each group consists of about 20 individuals who have a chance to be one of 15 to 20 selected as astronaut candidates in January.

The group consists of USAF Capt. Mark E. Almquist, Lancaster, Calif; Kenneth Cockrell, NASA Johnson Space Center; USAF Maj. Eileen M. Collins, Edwards AFB, Calif; Javier de Luis, Ph.D., Cambridge, Mass.; Dean B. Eppler, Ph.D., Las Vegas; USAF Maj. Lance C. Grace, Holloman AFB, NM; USAF Capt. William G. Gregory, Edwards AFB, Calif.; John M. Grunsfeld, Ph.D., Pasadena, Calif.; Butler P. Hine III, Ph.D., Cupertino, Calif.; Benjamin D. Levine, M.D., Dallas; Thomas P. Moore, M.D., Ph.D., Minneapolis, Minn.; David A. Noever, Ph.D., Huntsville, Ala.; USAF Capt. Mark L. Polansky, Niceville, Fla.; USAF Capt. Mark W. Stephenson, Newburgh, NY; William C. Stone, Ph.D., Derwood, Md.; USN LCdr. Sharon K. Wallace, Bonita, Calif.; USMC Maj. Terrence W. Wilcutt Patuxent River, Md.; USAF Maj. Robert J. Wood, Niceville, Fla.; Albert Yen, NASA Jet Propulsion Laboratory, Pasadena, Calif.; and USMC Capt. Peter E. Yount, Lexington Park, Md.

Applicants receiving interviews were chosen from nearly 2500 total applications received prior to the June 30 deadline. Those received after the deadline are eligible for consideration for the next selection in 1992. The number of candidates selected every 2 years will vary based on flight rate, program requirements and attrition.

- end-

NASA News

National Aeronautics and
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For Release:
September 29, 1989

RELEASE: 89-154

ASTRONAUTS NAMED FOR FIVE SPACE SHUTTLE MISSIONS

Astronaut crew assignments have been made for five Space Shuttle missions in late 1990 and early 1991, including the first assignments from the astronaut class of 1987, the first U.S. Coast Guard astronaut to fly, the first European Space Agency (ESA) astronaut to be named as a mission specialist and the first black woman to be selected for space flight.

The crew of the STS-41 mission, set for October 1990, will be commanded by USN Capt. Richard N. Richards. USMC Lt. Col. Robert D. Cabana has been named as pilot. Mission specialists are USN Capt. William M. Shepherd, USCG Cmdr. Bruce E. Melnick, and USAF Maj. Thomas D. Akers. Melnick and Akers will become the first of the astronaut class of 1987 to fly in space. At an orbital altitude of 160 miles, the crew of Atlantis will deploy the space probe ULYSSES on its way to a major solar science mission in polar orbit around the sun.

USN Capt. Michael L. Coats will command the crew of Discovery on STS-39, an unclassified Department of Defense mission scheduled for November 1990. The pilot will be USAF Maj. L. Blaine Hammond, Jr. Mission specialists are Gregory J. Harbaugh and USAF Maj. Donald R. McMonagle. Previously assigned as mission specialists for the flight are USAF Col. Guion S. Bluford, Jr., Richard J. Hieb, Ph.D., and Charles Lacy Veach. During the 8-day mission, the crew will deploy, rendezvous with and retrieve the free-flying Infrared Background Signature Survey, a sensor experiment to gather signature data on a variety of infrared, visible and ultraviolet sources.

- more -

Kathryn D. Sullivan, Ph.D., and C. Michael Foale, Ph.D., have been named as mission specialists for the Atmospheric Laboratory for Applications and Science (ATLAS-01) mission, STS-45. In March 1991, the crew of Columbia will spend 9 days in Earth orbit conducting studies of the sun and of the Earth's atmosphere in efforts to better understand the effect of solar activity on the Earth's climate and environment.

ATLAS-01 payload specialists Michael L. Lampton, Ph.D., of the University of California at Berkley, and Byron K. Lichtenberg, of Payload Systems, Inc., were selected for this mission in 1984. Additional crew members will be announced later.

In another partial crew assignment, USN Cmdr. Robert L. "Hoot" Gibson has been named to command the crew of STS-46. NASA astronauts Jeffrey A. Hoffman, Ph.D., and Franklin R. Chang-Diaz, Ph.D., plus Claude Nicollier, a European Space Agency (ESA) astronaut assigned to NASA, have been named to fly as mission specialists. During their 7-day mission, the crew of Atlantis will deploy the European Retrievable Carrier (EURECA), an ESA-sponsored free flying platform which will be retrieved and returned to Earth 8 months later.

This first flight of EURECA features 5 multi-user facilities serving some 45 principal investigators in the material and life sciences. In addition, the crew will demonstrate the Tethered Satellite System (TSS), a joint project between NASA and the Italian space agency, Agenzia Spaziale Italiana. The Shuttle-attached TSS will provide for the deployment, operation and retrieval of a data gathering probe through the use of a tether system which provides constant physical and electrical connection and RF communication between the probe and the Shuttle.

The STS-47 crew for Spacelab-J, a joint venture between the United States and Japan to conduct experiments in life sciences and materials processing, include mission specialists USAF Lt. Col. Mark C. Lee and N. Jan Davis, Ph.D. Mae C. Jemison, M.D., also will fly aboard Discovery on that mission in June 1991. Jemison, assigned as a payload specialist, becomes the first black woman to be selected for a space flight. Other crew members will be named later.

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Richards, who will make his second space flight, his first as commander, flew as pilot on STS-28. He was born August 24, 1946, in Key West, Fla., but considers St. Louis his hometown.

Cabana will make his first flight in space. He was born Jan. 23, 1949, in Minneapolis.

Shepherd will make his second flight, having flown as a mission specialist on STS-27. He was born July 26, 1949, in Oak Ridge, Tenn.

Melnick will make his first space flight. He was born Dec. 5, 1949, in New York City, but considers Clearwater, Fla., his hometown.

Akers will make his first flight in space. He was born May 20, 1951, in St. Louis, but considers Eminence, Mo., his hometown.

Coats will make his third space flight, his second as commander. He flew as pilot of STS-41D and as commander of STS-29. Coats was born Jan. 16, 1946, in Sacramento, Calif., but considers Riverside, Calif., his hometown.

Hammond will make his first flight. He was born Jan. 16, 1952, in Savannah, Ga.

McMonagle, selected in 1987 as a pilot, will make his first flight as a mission specialist. He was born May 14, 1952, in Flint, Mich.

Harbaugh also will make his first flight in space. He was born April 15, 1956, in Cleveland, but Willoughby, Ohio, is his hometown.

Sullivan, currently in training for her second space flight, STS-31, will make her third flight. She flew previously as a mission specialist on STS-41G. Sullivan was born Oct. 3, 1951, in Paterson, N.J., but considers Woodland Hills, Calif., her hometown.

Foale, an American citizen born in England, will make his first flight in space. He was born Jan. 6, 1957, in Louth, but considers Cambridge, England, his hometown.

Gibson, making his fourth flight, has flown previously as pilot on STS-41B and as commander on STS-61C and STS-27. He was born Oct. 30, 1946, in Cooperstown, N.Y., but Lakewood, Calif., is his hometown.

Hoffman, who will make his third flight, is currently in training for his second Shuttle mission, STS-35. He flew as a mission specialist on STS-51D. Hoffman was born Nov. 2, 1944, in Brooklyn, N.Y., but considers Scarsdale, N.Y., his hometown.

Chang-Diaz, currently preparing for mission STS-34, will make his third flight. He flew previously as a mission specialist on STS-61C. Chang-Diaz was born April 5, 1950, in San Jose, Costa Rica.

- more -

Nicollier, making his first flight, will be the first ESA astronaut to fly as a mission specialist. Under a special agreement between NASA and ESA, he was assigned to receive mission specialist training at NASA in 1980. He was born Sept. 2, 1944, in Vevey, Switzerland.

Lee flew as a mission specialist on STS-30. He was born Aug. 14, 1952, in Viroqua, Wis.

Davis, making her first space flight, was born Nov. 1, 1953, in Cocoa Beach, Fla., but considers Huntsville, Ala., her hometown.

Jemison will make her first flight in space. She was born Oct. 17, 1956, in Decatur, Ala.

- end -

NASA

SPACE SHUTTLE MISSION STS-34
PRESS KIT

OCTOBER 1989

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CONTENTS

National Aeronautics and
Space Administration

Washington, D.C.

RELEASE: 89-

SHUTTLE ATLANTIS TO DEPLOY GALILEO PROBE TOWARD JUPITER

Space Shuttle mission STS-34 will deploy the Galileo planetary exploration spacecraft into low-Earth orbit starting Galileo on its journey to explore Jupiter. Galileo will be the second planetary probe deployed from the Shuttle this year following Atlantis' successful launch of Magellan toward Venus exploration in May.

Following deployment about 6 hours after launch, Galileo will be propelled on a trajectory, known as Venus-Earth-Earth Gravity Assist (VEEGA) by an Air Force-developed, inertial upper stage (IUS). Galileo's trajectory will swing around Venus, the sun and Earth before Galileo makes it's way toward Jupiter.

Flying the VEEGA track, Galileo will arrive at Venus in February 1990. During the flyby, Galileo will make measurements to determine the presence of lightning on Venus and take time-lapse photography of Venus' cloud circulation patterns. Accelerated by Venus' gravity, the spacecraft will head back to Earth.

Enroute, Galileo will activate onboard remote-sensing equipment to gather near-infrared data on the composition and characteristics of the far side of Earth's moon. Galileo also will map the hydrogen distribution of the Earth's atmosphere.

Acquiring additional energy from the Earth's gravitational forces, Galileo will travel on a 2-year journey around the sun spending 10 months inside an asteroid belt. On Oct. 29, 1991, Galileo wlll pass within 600 miles of the asteroid Gaspra.

On the second Earth flyby in December 1992, Galileo will photograph the north pole of the moon in an effort to determine if ice exists. Outbound, Galileo will activate the time-lapse photography system to produce a "movie" of the moon orbiting Earth.

Racing toward Jupiter, Galileo will make a second trek through the asteroid belt passing within 600 miles of asteroid Ida on Aug. 29, 1993. Science data gathered from both asteroid encounters will focus on surface geology and composition.

Five months prior to the Dec. 7, 1995, arrival at Jupiter, Galileo's atmospheric probe, encased in an oval heat shield, will spin away from the orbiter at a rate of 5 revolutions per minute (rpm) and follow a ballistic trajectory aimed at a spot 6 degrees north of Jupiter's equator. The probe will enter Jupiter's atmosphere at a shallow angle to avoid burning up like a meteor or ricocheting off the atmosphere back into space.

At approximately Mach 1 speed, the probe's pilot parachute will deploy, removing the deceleration module aft cover. Deployment of the main parachute will follow, pulling the descent module out of the aeroshell to expose the instrument-sensing elements. During the 75-minute descent into the Jovian atmosphere, the probe will use the orbiter to transmit data back to Earth. After 75 minutes, the probe will be crushed under the heavy atmospheric pressure.

The Galileo orbiter will continue its primary mission, orbiting around Jupiter and four of its satellites, returning science data for the next 22 months.

Galileo's scientific goals include the study of the chemical composition, state and dynamics of the Jovian atmosphere and satellites, and the investigation of the structure and physical dynamics of the powerful Jovian magnetosphere.

Overall responsibility for management of the project, including orbiter development, resides at NASA's Jet Propulsion Laboratory, Pasadena, Calif. The NASA Ames Research Center, Mountain View, Calif., manages the probe system. JPL built the 2,500-lb. spacecraft and Hughes Aircraft Co. built the 740-lb. probe.

Modifications made to Galileo since flight postponement in 1986 include the addition of sunshields to the base and top of the antenna, new thermal control surfaces, blankets and heaters. Because of the extended length of the mission, the electrical circuitry of the thermoelectric generator has been revised to reduce power demand throughout the mission to assure adequate power supply for mission completion.

Joining Galileo in the payload bay of Atlantis will be the Shuttle Solar Backscatter Ultraviolet (SSBUV) instrument. The SSBUV is designed to provide calibration of backscatter ultraviolet instruments currently being flown on free-flying satellites. SSBUV's primary objective is to check the calibration of the ozone sounders on satellites to verify the accuracy of the data set of atmospheric ozone and solar irradiance data.

The SSBUV is contained in two Get Away Special canisters in the payload bay and weighs about 1219 lbs . One canister contains the SSBUV spectrometer and five supporting optical sensors. The second canister houses data, command and power systems. An interconnecting cable provides the communication link between the two canisters.

Atlantis also will carry several secondary payloads involving radiation measurements, polymer morphology, lightning research, microgravity effects on plants and a student experiment on ice crystal growth in space.

Commander of the 31st Shuttle mission is Donald E. Williams, Captain, USN. Michael J. McCulley, Commander, USN, is Pilot. Williams flew as Pilot of mission STS 51-D in April 1985. McCulley will be making his first Shuttle flight.

Mission Specialists are Shannon W. Lucid, Ph.D.; Franklin R. Chang-Diaz, Ph.D.; and Ellen S. Baker, M.D. Lucid previously flew as a Mission Specialist on STS 51-G in June 1985. Chang-Diaz flew as a Mission Specialist on STS 61-C in January 1986. Baker is making her first Shuttle flight.

Liftoff of the fifth flight of orbiter Atlantis is scheduled for 1:29 p.m. EDT on Oct. 12 from Kennedy Space Center, Fla., launch pad 39-B, into a 160-nautical-mile, 34.3-degree orbit. Nominal mission duration is 5 days, 2 hours, 45 minutes. Deorbit is planned on orbit 81, with landing scheduled for 4:14 p.m. EDT on Oct. 17 at Edwards Air Force Base, Calif.

Liftoff on Oct. 12 could occur during a 10-minute period. The launch window grows each day reaching a maximum of 47 minutes on Nov. 2. The window then decreases each day through the remainder of the launch opportunity which ends Nov. 21. The window is dictated by the need for a daylight landing opportunity at the trans-Atlantic landing abort sites and the performance constraint of Galileo's inertial upper stage.

After landing at Edwards AFB, Atlantis will be towed to the NASA Ames-Dryden Flight Research Facility, hoisted atop the Shuttle Carrier Aircraft and ferried back to the Kennedy Space Center to begin processing for its next flight.

- end -

GENERAL INFORMATION

NASA Select Television Transmission

NASA Select television is available on Satcom F-2R, Transponder 13, C-band located at 72 degrees west longitude, frequency 3960.0 MHz, vertical polarization, audio monaural 6.8 MHz.

The schedule for tv transmissions from the orbiter and for the change-of-shift briefings from Johnson Space Center, Houston, will be available during the mission at Kennedy Space Center, Fla.; Marshall Space Flight Center, Huntsville, Ala.; Johnson Space Center; and NASA Headquarters, Washington, D.C. The schedule will be updated daily to reflect changes dictated by mission operations.

TV schedules also may be obtained by calling COMSTOR, 713/483-5817. COMSTOR is a computer data base service requiring the use of a telephone modem. Voice updates of the TV schedule may be obtained by dialing 202/755-1788. This service is updated daily at noon EDT.

Special Note to Broadcasters

In the 5 workdays before launch, short sound bites of astronaut interviews with the STS-34 crew will be available to broadcasters by calling 202/755-1788 between 8 a.m. and noon EDT.

Status Reports

Status reports on countdown and mission progress, on-orbit activities and landing operations will be produced by the appropriate NASA news center.

Briefings

An STS-34 mission press briefing schedule will be issued prior to launch. During the mission, flight control personnel will be on 8-hour shifts. Change-of-shift briefings by the off-going flight director will occur at approximately 8-hour intervals.

STS-34 QUICK LOOK

Launch Date: Oct. 12, 1989
Launch Window: 1:29 p.m. - 1:39 p.m. EDT
Launch Site: Kennedy Space Center, Fla., Pad 39B
Orbiter: Atlantis (OV-104)
Altitude: 160 nm
Inclination: 34.30 degrees
Duration: 5 flight days
Landing Date/Time: Oct. 17, 1989, 4:14 p.m. EDT

Primary Landing Site: Edwards AFB, Calif.

Abort Landing Sites:
Return to Launch Site - Kennedy Space Center, Fla.
Transoceanic Abort Landing - Ben Guerir, Morocco
Abort Once Around - Edwards AFB, Calif.

Crew:
Donald E. Williams, Commander
Michael J. McCulley, Pilot
Shannon W. Lucid, Mission Specialist
Ellen S. Baker, Mission Specialist
Franklin R. Chang-Diaz, Mission Specialist

Cargo Bay Payloads:
Galileo spacecraft to Jupiter (primary payload)
Shuttle Solar Backscatter Ultraviolet (SSBUV)

Middeck Payloads:
Growth Hormone Concentration & Distribution in Plants (GHCD)
Mesoscale Lightning Experiment (MLR)
Polymer Morphology (PM)
Sensor Technology Experiment (STEX)

LAUNCH PREPARATIONS, COUNTDOWN AND LIFTOFF

Processing activities began on Atlantis for the STS-34 mission on May 16 when Atlantis was towed to Orbiter Processing Facility (OPF) bay 2 after arrival from NASA's Ames-Dryden Flight Research Facility in California. STS-30 post-flight deconfiguration and inspections were conducted in the processing hangar.

As planned, the three main engines were removed the last week of May and taken to the main engine shop in the Vehicle Assembly Building (VAB) for the replacement of several components including the high pressure oxidizer turbopumps. The engines were reinstalled the first week of July, while the ship was in the OPF. Engine 2027 is installed in the number one position, engine 2030 is in the number two position and engine 2029 is in the number three position.

The right hand Orbital Maneuvering System (OMS) pod was removed in mid-June for repairs. A propellant tank needed for Atlantis' pod was scheduled for delivery too late to support integrated testing. As a result, Discovery's right pod was installed on Atlantis about 2 weeks later. The left OMS pod was removed July 9 and reinstalled 2 1/2 weeks later. Both pods had dynatubes and helium isolation valve repairs in the Hypergolic Maintenance Facility.

About 34 modifications have been implemented since the STS-30 mission. One significant modification is a cooling system for the radioisotope thermoelectric generators (RTG). The RTG fuel is plutonium dioxide which generates heat as a result of its normal decay. The heat is converted to energy and used to provide electrical power for the Galileo spacecraft. A mixture of alcohol and water flows in the special cooling system to lower the RTG case temperature and maintain a desired temperature to the payload instrumentation in the vicinity of the RTGs. These cooling lines are mounted on the port side of the orbiter from the aft compartment to a control panel in bay 4.

Another modification, called "flutter buffet," features special instrumentation on the vertical tail and right and left outboard elevons. Ten accelerometers were added to the vertical tail and one on each of the elevons. These instruments are designed to measure in-flight loads on the orbiter's structure. Atlantis is the only vehicle that will be equipped with this instrumentation.

Improved controllers for the water spray boilers and auxiliary power units were installed. Other improvements were made to the orbiter's structure and thermal protection system, mechanical systems, propulsion system and avionics system.

Stacking of solid rocket motor (SRM) segments for flight began with the left aft booster on Mobile Launcher Platform 1 in the VAB on June 15. Booster stacking operations were completed by July 22 and the external tank was mated to the two boosters on July 30.

Flight crew members performed the Crew Equipment Interface Test on July 29 to become familiar with Atlantis' crew compartment, vehicle configuration and equipment associated with the mission.

The Galileo probe arrived at the Spacecraft Assembly and Encapsulation Facility (SAEF) 2 on April 17 and the spacecraft arrived on May 16. While at SAEF-2, the spacecraft and probe were joined and tested together to verify critical connections. Galileo was delivered to the Vertical Processing Facility (VPF) on Aug. 1. The Inertial Upper Stage (IUS) was delivered to the VPF on July 30. The Galileo/IUS were joined together on Aug. 3 and all integrated testing was performed during the second week of August.

The Shuttle Solar Backscatter Ultraviolet (SSBUV) experiment, contained in two Get Away Special (GAS) canisters, was mounted on a special GAS beam in Atlantis' payload bay on July 24. Interface verification tests were performed the next day.

Atlantis was transferred from the OPF to the VAB on Aug. 21, where it was mated to the external tank and SRBs. A Shuttle Interface Test was conducted in the VAB to check the mechanical and electrical connections between the various elements of the Shuttle vehicle and onboard flight systems.

The assembled Space Shuttle vehicle was rolled out of the VAB aboard its mobile launcher platform for the 4.2 mile trip to Launch Pad 39-B on Aug. 29. Galileo and its IUS upper stage were transferred from the VPF to Launch Pad 39-B on Aug. 25. The payload was installed in Atlantis' payload bay on Aug. 30.

The payload interface verification test was planned for Sept. 7 to verify connections between the Shuttle and the payload. An end-to-end test was planned for Sept. 8 to verify communications between the spacecraft and ground controllers. Testing of the IUS was planned about 2 weeks prior to launch in parallel with Shuttle launch preparations.

A Countdown Demonstration Test, a dress rehearsal for the STS-34 flight crew and KSC launch team, is designed as a practice countdown for the launch. At press time, it was planned for Sept. 14 and 15.

One of the unique STS-34 processing milestones planned was a simulation exercise for the installation of the RTGs. Simulated RTGs were to be used in the 2-day event scheduled within the first week after Atlantis arrives at the launch pad. The test is designed to give workers experience for the installation of the RTGs, a first in the Shuttle program. In addition, access requirements will be identified and procedures will be verified.

Another test scheduled at the pad is installation of the flight RTGs and an associated test and checkout of the RTG cooling system planned for the third week of September. This test will verify the total RTG cooling system and connections. The RTGs will be removed at the completion of the 3-day cooling system test and returned to the RTG facility. The two flight RTGs will be reinstalled on the spacecraft 6 days before launch.

Launch preparations scheduled the last 2 weeks prior to launch countdown include final vehicle ordnance activities, such as power-on stray-voltage checks and resistance checks of firing circuits; loading the fuel cell storage tanks; pressurizing the hypergolic propellant tanks aboard the vehicle; final payload closeouts; and a final functional check of the range safety and SRB ignition, safe and arm devices.

The launch countdown is scheduled to pick up at the T-minus 43-hour mark, leading up to the STS-34 launch. Atlantis' fifth launch will be conducted by a joint NASA/industry team from Firing Room 1 in the Launch Control Center.

MAJOR COUNTDOWN MILESTONES

Countdown	Event
T-43 Hours	Power up Space Shuttle vehicle.
T-34 Hours	Begin orbiter and ground support equipment closeouts for launch.
T-30 Hours	Activate orbiter's navigation aids.
T-27 Hours (holding)	Enter first built-in hold for 8 hours.
T-27 Hours (counting)	Begin preparations for loading fuel cell storage tanks with liquid oxygen and liquid hydrogen reactants.
T-25 Hours	Load orbiter's fuel cell tanks with liquid oxygen.
T-22 Hours, 30 minutes	Load orbiter's fuel cell tanks with liquid hydrogen.
T-22 Hours	Perform interface check between Houston Mission Control and Merritt Island Launch Area (MILA) tracking station.
T-20 Hours	Activate and warm up inertial measurement units (IMU).
T-19 Hours (holding)	Enter 8-hour built-in hold. Activate orbiter communications system.
T-19 hours (counting)	Resume countdown. Continue preparations to load external tank, orbiter closeouts and preparations to move the Rotating Service Structure (RSS).
T-11 Hours (holding)	Start 14-hour, 40 minute built-in hold. Perform orbiter ascent switch list in orbiter flight and middecks.
T-11 Hours (counting)	Retract RSS from vehicle to launch position.
T-9 Hours	Activate orbiter's fuel cells.
T-8 Hours	Configure Mission Control communications for launch. Start clearing blast danger area.
T-6 Hours, 30 minutes	Perform Eastern Test Range open loop command test.
T-6 Hours (holding)	Enter 1-hour built-in hold. Receive management "go" for tanking.
T-6 Hours (counting)	Start external tank chilldown and propellant loading.

T-5 Hours	Start IMU pre-flight calibration.
T-4 Hours	Perform MILA antenna alignment.
T-3 Hours (holding)	2-hour built-in hold begins. Loading of external tank is complete and in a stable replenish mode. Ice team goes to pad for inspections. Closeout crew goes to white room to begin preparing orbiter's cabin for flight crew's entry. Wake flight crew (launch minus 4 hours, 55 minutes).
T-3 Hours (counting)	Resume countdown.
T-2 Hours, 55 minutes	Flight crew departs O&C Building for Launch Pad 39-B (Launch minus 3 hours,15 minutes).
T-2 Hours, 30 minutes	Crew enters orbiter vehicle (Launch minus 2 Hours, 50 minutes).
T-60 minutes	Start pre-flight alignment of IMUs.
T-20 minutes (holding)	10-minute built-in hold begins.
T-20 minutes (counting)	Configure orbiter computers for launch.
T-10 minutes	White room closeout crew cleared through launch danger area roadblocks.
T-9 minutes (holding)	40-minute built-in hold begins. Perform status check and receive Launch Director and Mission Management Team "go."
T-9 minutes (counting)	Start ground launch sequencer.
T-7 minutes, 30 seconds	Retract orbiter access arm.
T-5 minutes	Pilot starts auxiliary power units. Arm range safety, solid rocket booster (SRB) ignition systems.
T-3 minutes, 30 seconds	Orbiter goes on internal power.
T-2 minutes, 55 seconds	Pressurize liquid oxygen tank for flight and retract gaseous oxygen vent hood.
T-1 minute, 57 seconds	Pressurize liquid hydrogen tank.
T-31 seconds	"Go" from ground computer for orbiter computers to start the automatic launch sequence.
T-28 seconds	Start SRB hydraulic power units.
T-21 seconds	Start SRB gimbal profile test.
T-6.6 seconds	Main engine start.
T-3 seconds	Main engines at 90 percent thrust.
T-0	SRB ignition, holddown post release and liftoff.
T+7 seconds	Shuttle clears launch tower and control switches to JSC.

Note: This countdown timeline may be adjusted in real time as necessary.

TRAJECTORY SEQUENCE OF EVENTS

EVENT	MET (d:h:m:s)	RELATIVE VELOCITY (fps)	MACH	ALTITUDE (ft.)
Launch	00/00:00:00			
Begin Roll Maneuver	00/00:00:09	165	.15	627
End Roll Maneuver	00/00:00:17	374	.33	2,898
SSME Throttle Down to 65%	00/00:00:34	833	.75	11,854
Max. Dyn. Pressure (Max Q)	00/00:00:52	1,260	1.2	28,037
SSME Throttle Up to 104%	00/00:01:01	1,499	1.49	38,681
SRB Staging	00/00:02:04	4,316	3.91	153,873
Negative Return	00/00:03:54	6,975	7.48	317,096
Main Engine Cutoff (MECO)	00/00:08:27	24,580	22.41	366,474
Zero Thrust	00/00:08:33	24,596	22.17	368,460
ET Separation	00/00:08:45			
OMS 2 Burn	00/00:39:48			
Galileo/IUS Deploy (orbit 5)	00/06:21:36			
Deorbit Burn (orbit 81)	05/01:45:00			
Landing (orbit 82)	05/02:45:00			

Apogee, Perigee at MECO:	157 x 39 nm
Apogee, Perigee post-OMS 2:	161 x 161 nm
Apogee, Perigee post deploy:	177 x 161 nm

SPACE SHUTTLE ABORT MODES

Space Shuttle launch abort philosophy aims toward safe and intact recovery of the flight crew, orbiter and its payload. Abort modes include:

* Abort-To-Orbit (ATO) -- Partial loss of main engine thrust late enough to permit reaching a minimal 105-nautical mile orbit with orbital maneuvering system engines.

* Abort-Once-Around (AOA) -- Earlier main engine shutdown with the capability to allow one orbit around before landing at Edwards Air Force Base, Calif.; White Sands Space Harbor (Northrup Strip), N.M.; or the Shuttle Landing Facility (SLF) at Kennedy Space Center (KSC), Fla.

• Trans-Atlantic Abort Landing (TAL) -- Loss of two main engines midway through powered flight would force a landing at Ben Guerir, Morocco; Moron, Spain; or Banjul, The Gambia.

• Return-To-Launch-Site (RTLS) -- Early shutdown of one or more engines and without enough energy to reach Ben Guerir, would result in a pitch around and thrust back toward KSC until within gliding distance of the SLF.

STS-34 contingency landing sites are Edwards AFB, White Sands, KSC, Ben Guerir, Moron and Banjul.

SUMMARY OF MAJOR ACTIVITIES

Day One

Ascent
Post-insertion checkout
Pre-deploy checkout
Galileo/Inertial Upper Stage (IUS) deploy
Detailed Secondary Objective (DSO)
Polymer Morphology (PM)
Sensor Technology Experiment (STEX) activation

Day Two

Galileo/IUS backup deploy opportunity
DSO
IMAX
PM
Shuttle Solar Backscatter Ultraviolet (SSBUV) activation
Shuttle Student Involvement Program (SSIP)

Day Three

DSO
IMAX
Mesoscale Lightning Experiment (MLE)
PM

Day Four

DSO
IMAX
MLE
PM
SSBUV deactivation

Day Five

DTO/DSO
GHCD operations
PM
STEX deactivation
Flight control systems (FCS) checkout
Cabin stow
Landing preparations

Day Six

PM stow
Deorbit preparation
Deorbit burn
Landing at Edwards AFB

LANDING AND POST LANDING OPERATIONS

Kennedy Space Center, Fla., is responsible for ground operations of the orbiter once it has rolled to a stop on the runway at Edwards Air Force Base, Calif. Those operations include preparing the Shuttle for the return trip to Kennedy.

After landing, the flight crew aboard Atlantis begins "safing" vehicle systems. Immediately after wheel stop, specially garbed technicians will first determine that any residual hazardous vapors are below significant levels for other safing operations to proceed.

A mobile white room is moved into place around the crew hatch once it is verified that there are no concentrations of toxic gases around the forward part of the vehicle. The flight crew is expected to leave Atlantis about 45 to 50 minutes after landing. As the crew exits, technicians enter the orbiter to complete the vehicle safing activity.

Once the initial aft safety assessment is made, access vehicles are positioned around the rear of the orbiter so that lines from the ground purge and cooling vehicles can be connected to the umbilical panels on the aft end of Atlantis.

Freon line connections are completed and coolant begins circulating through the umbilicials to aid in heat rejection and protect the orbiter's electronic equipment. Other lines provide cooled, humidified air to the payload bay and other cavities to remove any residual fumes and provide a safe environment inside Atlantis.

A tow tractor will be connected to Atlantis and the vehicle will be pulled off the runway at Edwards and positioned inside the Mate/Demate Device (MDD) at nearby Ames-Dryden Flight Research Facility. After the Shuttle has been jacked and leveled, residual fuel cell cryogenics are drained and unused pyrotechnic devices are disconnected prior to returning the orbiter to Kennedy.

The aerodynamic tail cone is installed over the three main engines, and the orbiter is bolted on top of the 747 Shuttle Carrier Aircraft for the ferry flight back to Florida. Pending completion of planned work and favorable weather conditions, the 747 would depart California about 6 days after landing for the cross-country ferry flight back to Florida. A refueling stop is necessary to complete the journey.

Once back at Kennedy, Atlantis will be pulled inside the hangar-like facility for post-flight inspections and in-flight anomaly troubleshooting. These operations are conducted in parallel with the start of routine systems reverification to prepare Atlantis for its next mission.

GALILEO

Galileo is a NASA spacecraft mission to Jupiter to study the planet's atmosphere, satellites and surrounding magnetosphere. It was named for the Italian renaissance scientist who discovered Jupiter's major moons by using the first astronomical telescope.

This mission will be the first to make direct measurements from an instrumented probe within Jupiter's atmosphere and the first to conduct long-term observations of the planet and its magnetosphere and satellites from orbit around Jupiter. It will be the first orbiter and atmospheric probe for any of the outer planets. On the way to Jupiter, Galileo also will observe Venus, the Earth-moon system, one or two asteroids and various phenomena in interplanetary space.

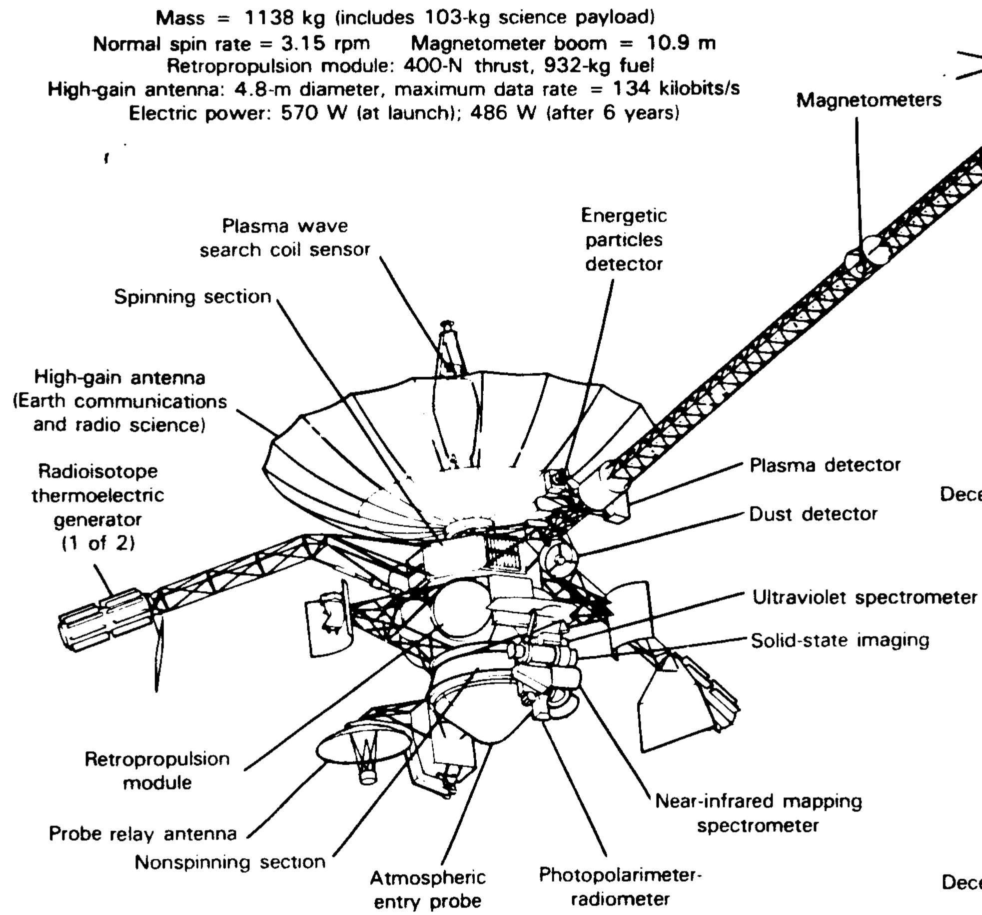
Galileo will be boosted into low-Earth orbit by the Shuttle Atlantis and then boosted out of Earth orbit by a solid rocket Inertial Upper Stage. The spacecraft will fly past Venus and twice by the Earth, using gravity assists from the planets to pick up enough speed to reach Jupiter. Travel time from launch to Jupiter is a little more than 6 years.

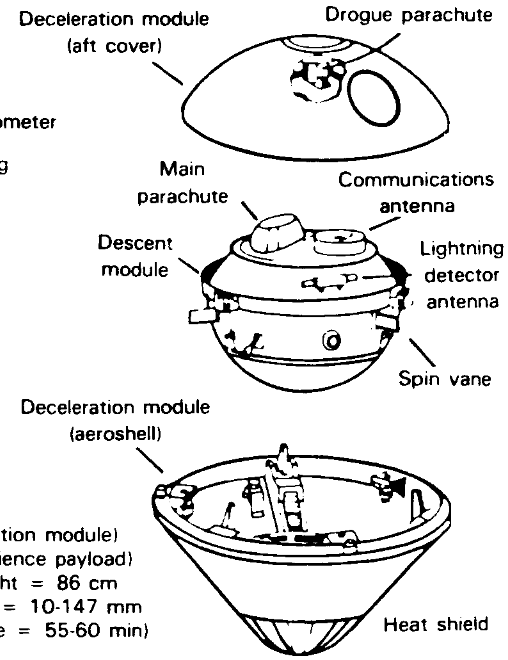
In December 1995, the Galileo atmospheric probe will conduct a brief, direct examination of Jupiter's atmosphere, while the larger part of the craft, the orbiter, begins a 22-month, 10-orbit tour of major satellites and the magnetosphere, including long-term observations of Jupiter throughout this phase.

The 2-ton Galileo orbiter spacecraft carries 9 scientific instruments. There are another six experiments on the 750-pound probe. The spacecraft radio link to Earth serves as an additional instrument for scientific measurements. The probe's scientific data will be relayed to Earth by the orbiter during the 75-minute period while the probe is descending into Jupiter's atmosphere. Galileo will communicate with its controllers and scientists through NASA's Deep Space Network, using tracking stations in California, Spain and Australia.

Orbiter

Mass = 1138 kg (includes 103-kg science payload)
Normal spin rate = 3.15 rpm Magnetometer boom = 10.9 m
Retropropulsion module: 400-N thrust, 932-kg fuel
High-gain antenna: 4.8-m diameter, maximum data rate = 134 kilobits/s
Electric power: 570 W (at launch); 486 W (after 6 years)





Probe

Mass = 335 kg (includes 213-kg deceleration module)
Descent module: 118 kg (includes 28-kg science payload)
Probe diameter = 125 cm Probe height = 86 cm
Heat shield: carbon-phenolic nose, thickness = 10-147 mm
Data rate = 128 bits/s (Li-SO, battery lifetime = 55-60 min)

GALILEO MISSION EVENTS

Launch Window (Atlantis and IUS)	Oct. 12 to Nov. 21, 1989
(Note: for both asteroids, closes in mid-October)	
Venus flyby (9,300 mi)	*Feb. 9, 1990
Venus data playback	Oct. 1990
Earth 1 flyby (about 600 mi)	*Dec. 8, 1990
Asteroid Gaspra flyby (600 mi)	*Oct. 29, 1991
Earth 2 flyby (200 mi)	*Dec. 8, 1992
Asteroid Ida flyby (600 mi)	*Aug. 28, 1993
Probe release	July 1995
Jupiter arrival	Dec. 7, 1995
(includes Io flyby, probe entry and relay, Jupiter orbit insertion)	
Orbital tour of Galilean satellites	Dec '95-Oct '97

*Exact dates may vary according to actual launch date

EARTH TO JUPITER

Galileo will make three planetary encounters in the course of its gravity-assisted flight to Jupiter. These provide opportunities for scientific observation and measurement of Venus and the Earth-moon system. The mission also has a chance to fly close to one or two asteroids, bodies which have never been observed close up, and obtain data on other phenomena of interplanetary space.

Scientists are currently studying how to use the Galileo scientific instruments and the limited ability to collect, store and transmit data during the early phase of flight to make the best use of these opportunities. Instruments designed to observe Jupiter's atmosphere from afar can improve our knowledge of the atmosphere of Venus and sensors designed for the study of Jupiter's moons can add to our information about our own moon.

VENUS

The Galileo spacecraft will approach Venus early in 1990 from the night side and pass across the sunlit hemisphere, allowing observation of the clouds and atmosphere. Both infrared and ultraviolet spectral observations are planned, as well as several camera images and other remote measurements. The search for deep cloud patterns and for lightning storms will be limited by the fact that all the Venus data must be tape-recorded on the spacecraft for playback 8 months later.

The spacecraft was originally designed to operate between Earth and Jupiter, where sunlight is 25 times weaker than at Earth and temperatures are much lower. The VEEGA mission will expose the spacecraft to a hotter environment from Earth to Venus and back. Spacecraft engineers devised a set of sunshades to protect the craft. For this system to work, the front end of the spacecraft must be aimed precisely at the Sun, with the main antenna furled for protection from the Sun's rays until after the first Earth flyby in December 1990. This precludes the use of the Galileo high-gain antenna and therefore, scientists must wait until the spacecraft is close to Earth to receive the recorded Venus data, transmitted through a low-gain antenna.

FIRST EARTH PASS

Approaching Earth for the first time about 14 months after launch, the Galileo spacecraft will observe, from a distance, the nightside of Earth and parts of both the sunlit and unlit sides of the moon. After passing Earth, Galileo will observe Earth's sunlit side. At this short range, scientific data are transmitted at the high rate using only the spacecraft's low-gain antennas. The high-gain antenna is to be unfurled like an umbrella, and its high-power transmitter turned on and checked out, about 5 months after the first Earth encounter.

FIRST ASTEROID

Nine months after the Earth passage and still in an elliptical solar orbit, Galileo will enter the asteroid belt, and two months later, will have its first asteroid encounter. Gaspra is believed to be a fairly representative main-belt asteroid, about 10 miles across and probably similar in composition to stony meteorites.

The spacecraft will pass within about 600 miles at a relative speed of about 18,000 miles per hour. It will collect several pictures of Gaspra and make spectral measurements to indicate its composition and physical properties.

SECOND EARTH PASS

Thirteen months after the Gaspra encounter, the spacecraft will have completed its 2-year elliptical orbit around the Sun and will arrive back at Earth. It will need a much larger ellipse (with a 6-year period) to reach as far as Jupiter. The second flyby of Earth will pump the orbit up to that size, acting as a natural apogee kick motor for the Galileo spacecraft.

Passing about 185 miles above the surface, near the altitude at which it had been deployed from the Space Shuttle almost three years earlier, Galileo will use Earth's gravitation to change the spacecraft's flight direction and pick up about 8,000 miles per hour in speed.

Each gravity-assist flyby requires about three rocket-thrusting sessions, using Galileo's onboard retropropulsion module, to fine-tune the flight path. The asteroid encounters require similar maneuvers to obtain the best observing conditions.

Passing the Earth for the last time, the spacecraft's scientific equipment will make thorough observations of the planet, both for comparison with Venus and Jupiter and to aid in Earth studies. If all goes well, there is a good chance that Galileo will enable scientists to record the motion of the moon about the Earth while the Earth itself rotates.

SECOND ASTEROID

Nine months after the final Earth flyby, Galileo may have a second asteroid-observing opportunity. Ida is about 20 miles across. Like Gaspra, Ida is believed to represent the majority of main-belt asteroids in composition, though there are believed to be differences between the two. Relative velocity for this flyby will be nearly 28,000 miles per hour, with a planned closest approach of about 600 miles.

APPROACHING JUPITER

Some 2 years after leaving Earth for the third time and 5 months before reaching Jupiter, Galileo's probe must separate from the orbiter. The spacecraft turns to aim the probe precisely for its entry point in the Jupiter atmosphere, spins up to 10 revolutions per minute and releases the spin-stabilized probe. Then the Galileo orbiter maneuvers again to aim for its own Jupiter encounter and resumes its scientific measurements of the interplanetary environment underway since the launch more than 5 years before.

While the probe is still approaching Jupiter, the orbiter will have its first two satellite encounters. After passing within 20,000 miles of Europa, it will fly about 600 miles above Io's volcano-torn surface, twenty times closer than the closest flyby altitude of Voyager in 1979.

AT JUPITER

The Probe at Jupiter

The probe mission has four phases: launch, cruise, coast and entry-descent. During launch and cruise, the probe will be carried by the orbiter and serviced by a common umbilical. The probe will be dormant during cruise except for annual checkouts of spacecraft systems and instruments. During this period, the orbiter will provide the probe with electric power, commands, data transmission and some thermal control.

Six hours before entering the atmosphere, the probe will be shooting through space at about 40,000 mph. At this time, its command unit signals "wake up" and instruments begin collecting data on lightning, radio emissions and energetic particles.

A few hours later, the probe will slam into Jupiter's atmosphere at 115,000 mph, fast enough to jet from Los Angeles to New York in 90 seconds. Deceleration to about Mach 1 -- the speed of sound -- should take just a few minutes. At maximum deceleration as the craft slows from 115,000 mph to 100 mph, it will be hurtling against a force 350 times Earth's gravity. The incandescent shock wave ahead of the probe will be as bright as the sun and reach searing temperatures of up to 28,000 degrees Fahrenheit. After the aerodynamic braking has slowed the probe, it will drop its heat shields and deploy its parachute. This will allow the probe to float down about 125 miles through the clouds, passing from a pressure of 1/10th that on Earth's surface to about 25 Earth atmospheres.

About 4 minutes after probe entry into Jupiter's atmosphere, a pilot chute deploys and explosive nuts shoot off the top section of the probe's protective shell. As the cover whips away, it pulls out and opens the main parachute attached to the inner capsule. What remains of the probe's outer shell, with its massive heat shield, falls away as the parachute slows the instrument module.

From there on, suspended from the main parachute, the probe's capsule with its activated instruments floats downward toward the bright clouds below.

The probe will pass through the white cirrus clouds of ammonia crystals - the highest cloud deck. Beneath this ammonia layer probably lie reddish-brown clouds of ammonium hydrosulfides. Once past this layer, the probe is expected to reach thick water clouds. This lowest cloud layer may act as a buffer between the uniformly mixed regions below and the turbulent swirl of gases above.

Jupiter's atmosphere is primarily hydrogen and helium. For most of its descent through Jupiter's three main cloud layers, the probe will be immersed in gases at or below room temperature. However, it may encounter hurricane winds up to 200 mph and lightning and heavy rain at the base of the water clouds believed to exist on the planet. Eventually, the probe will sink below these clouds, where rising pressure and temperature will destroy it. The probe's active life in Jupiter's atmosphere is expected to be about 75 minutes in length. The probe batteries are not expected to last beyond this point, and the relaying orbiter will move out of reach.

To understand this huge gas planet, scientists must find out about its chemical components and the dynamics of its atmosphere. So far, scientific data are limited to a two-dimensional view (pictures of the planet's cloud tops) of a three-dimensional process (Jupiter's weather). But to explore such phenomena as the planet's incredible coloring, the Great Red Spot and the swirling shapes and high-speed motion of its topmost clouds, scientists must penetrate Jupiter's visible surface and investigate the atmosphere concealed in the deep-lying layers below.

A set of six scientific instruments on the probe will measure, among other things, the radiation field near Jupiter, the temperature, pressure, density and composition of the planet's atmosphere from its first faint outer traces to the hot, murky hydrogen atmosphere 100 miles below the cloud tops. All of the information will be gathered during the probe's descent on an 8-foot parachute. Probe data will be sent to the Galileo Orbiter 133,000 miles overhead then relayed across the half billion miles to Deep Space Network stations on Earth.

To return its science, the probe relay radio aboard the orbiter must automatically acquire the probe signal below within 50 seconds, with a success probability of 99.5 percent. It must reacquire the signal immediately should it become lost.

To survive the heat and pressure of entry, the probe spacecraft is composed of two separate units: an inner capsule containing the scientific instruments, encased in a virtually impenetrable outer shell. The probe weighs 750 pounds. The outer shell is almost all heat shield material.

The Orbiter at Jupiter

After releasing the probe, the orbiter will use its main engine to go into orbit around Jupiter. This orbit, the first of 10 planned, will have a period of about 8 months. A close flyby of Ganymede in July 1996 will shorten the orbit, and each time the Galileo orbiter returns to the inner zone of satellites, it will make a gravity-assist close pass over one or another of the satellites, changing Galileo's orbit while making close observations. These satellite encounters will be at altitudes as close as 125 miles above their surfaces. Throughout the 22-month orbital phase, Galileo will continue observing the planet and the satellites and continue gathering data on the magnetospheric environment.

SCIENTIFIC ACTIVITIES

Galileo's scientific experiments will be carried out by more than 100 scientists from six nations. Except for the radio science investigation, these are supported by dedicated instruments on the Galileo orbiter and probe. NASA has appointed 15 interdisciplinary scientists whose studies include data from more than one Galileo instrument.

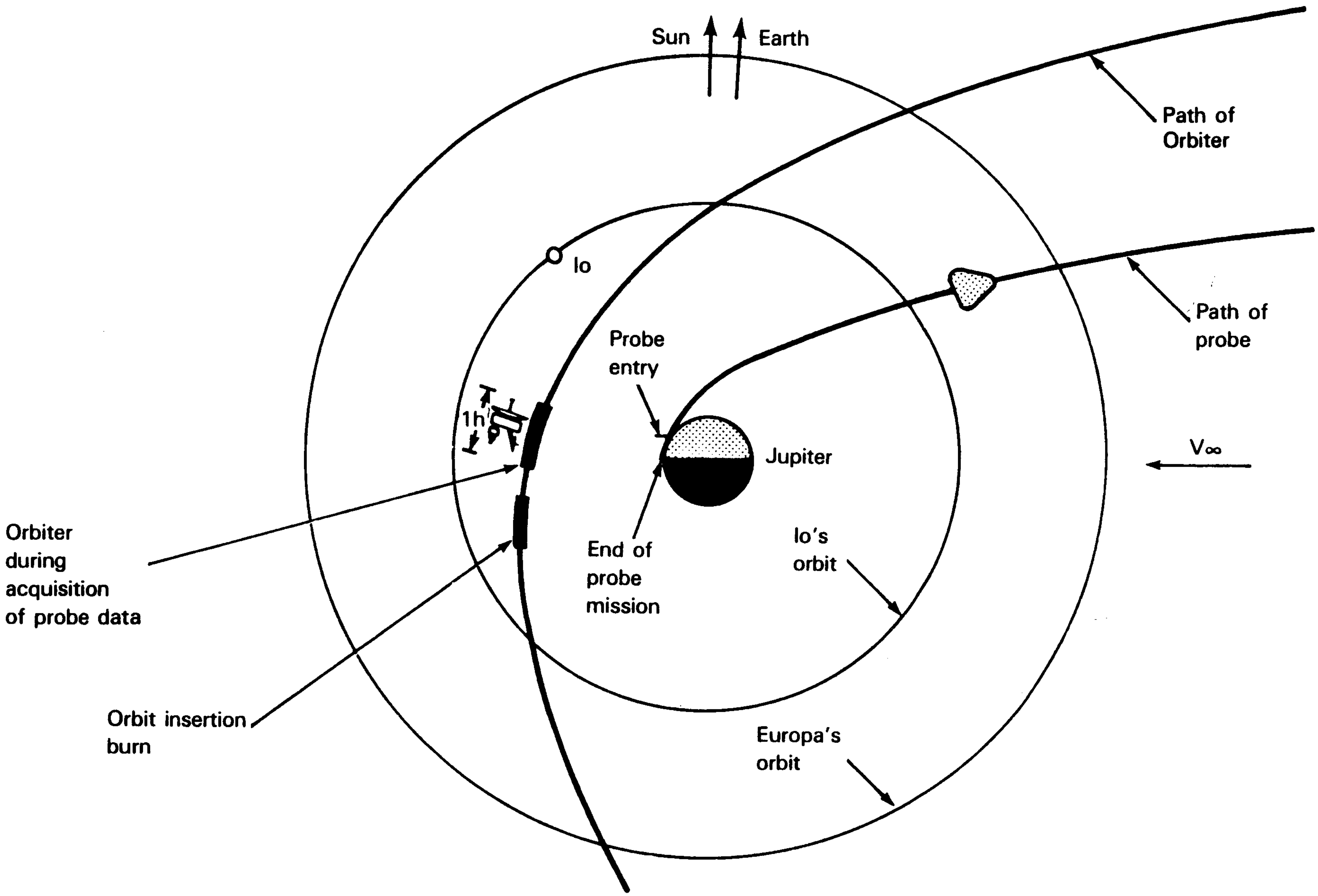
The instruments aboard the probe will measure the temperatures and pressure of Jupiter's atmosphere at varying altitudes and determine its chemical composition including major and minor constituents (such as hydrogen, helium, ammonia, methane, and water) and the ratio of hydrogen to helium. Jupiter is thought to have a bulk composition similar to that of the primitive solar nebula from which it was formed. Precise determination of the ratio of hydrogen to helium would provide an important factual check of the Big Bang theory of the genesis of the universe.

Other probe experiments will determine the location and structure of Jupiter's clouds, the existence and nature of its lightning, and the amount of heat radiating from the planet compared to the heat absorbed from sunlight.

In addition, measurements will be made of Jupiter's numerous radio emissions and of the high-energy particles trapped in the planet's innermost magnetic field. These measurements for Galileo will be made within a distance of 26,000 miles from Jupiter's cloud tops, far closer than the previous closest approach to Jupiter by Pioneer 11. The probe also will determine vertical wind shears using Doppler radio measurements made of probe motions from the radio receiver aboard the orbiter.

Jupiter appears to radiate about twice as much energy as it receives from the sun and the resulting convection currents from Jupiter's internal heat source towards its cooler polar regions could explain some of the planet's unusual weather patterns.

Jupiter is over 11 times the diameter of Earth and spins about two and one-half times faster -- a jovian day is only 10 hours long. A point on the equator of Jupiter's visible surface races along at 28,000 mph. This rapid spin may account for many of the bizarre circulation patterns observed on the planet.


Sun
Earth
Path of Orbiter
Io
Path of probe
Probe entry
1h
Jupiter
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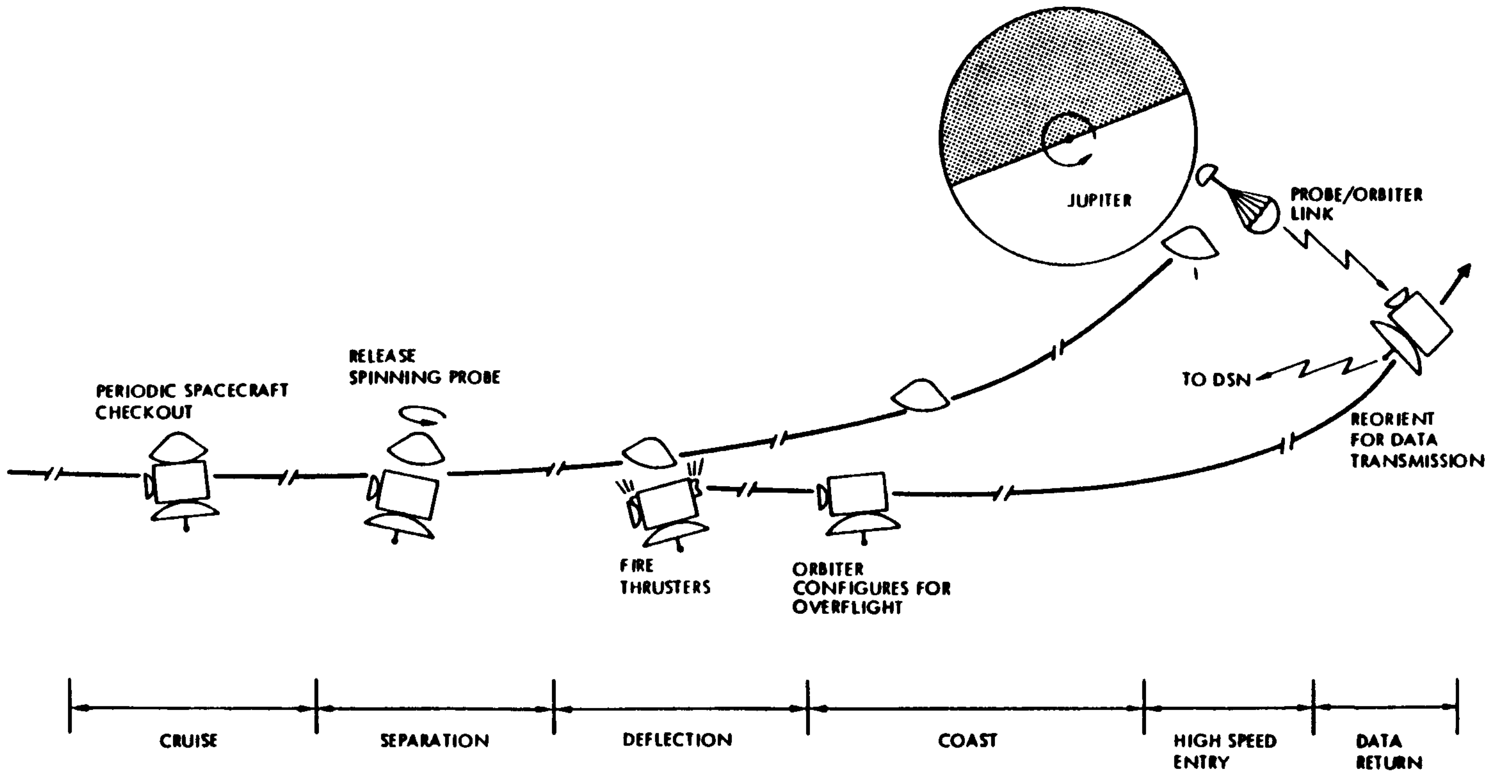
End of probe mission
Io's orbit
Orbit insertion burn
Europa's orbit


JUPITER
PROBE/ORBITER LINK
TO DSN
REORIENT FOR DATA TRANSMISSION
RELEASE SPINNING PROBE
PERIODIC SPACECRAFT CHECKOUT
FIRE THRUSTERS
ORBITER CONFIGURES FOR OVERFLIGHT
CRUISE
SEPARATION
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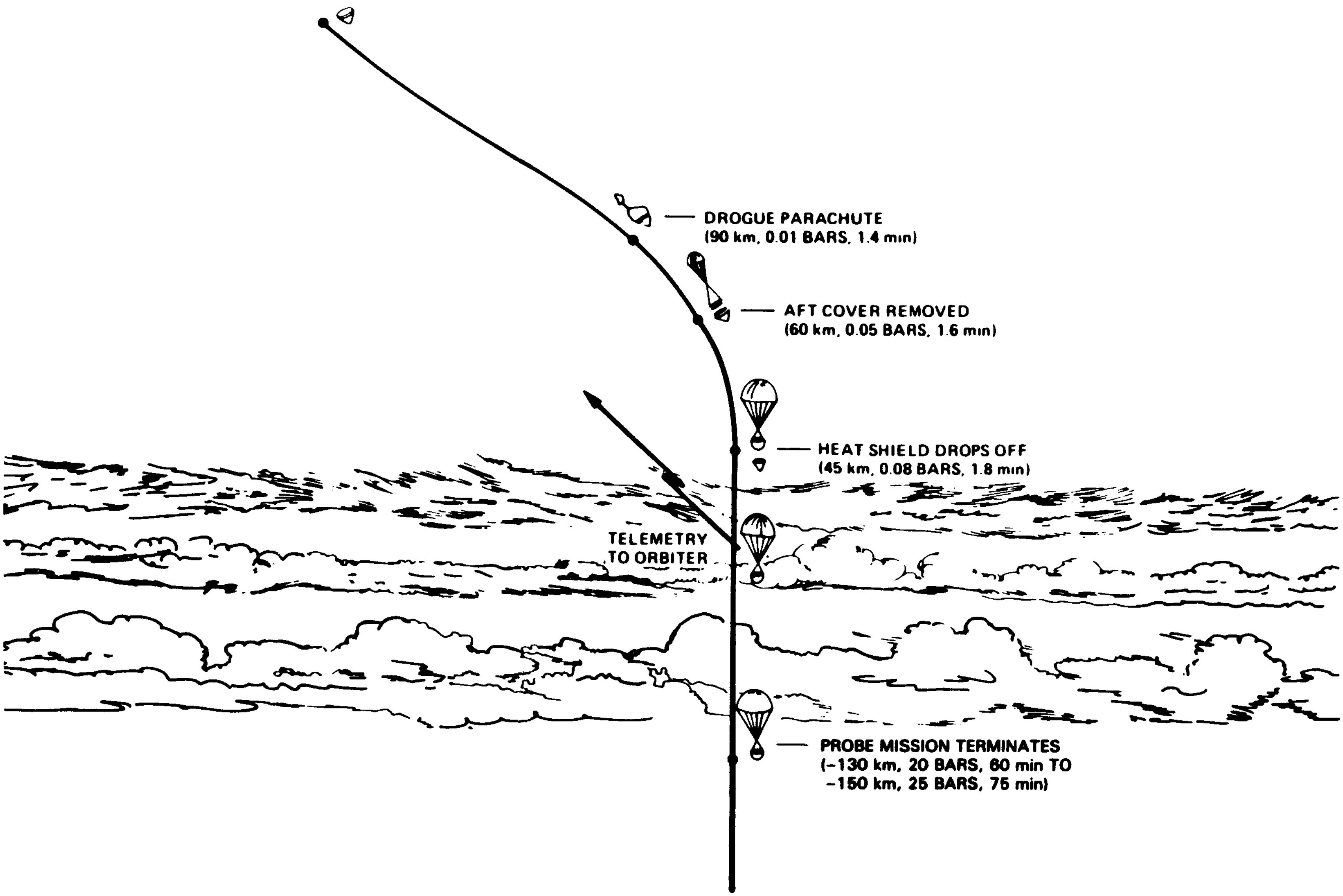
COAST
HIGH SPEED ENTRY
DATA RETURN


DROGUE PARACHUTE
(90 km, 0.01 BARS, 1.4 min)
AFT COVER REMOVED
(60 km, 0.05 BARS, 1.6 min)
HEAT SHIELD DROPS OFF
(45 km, 0.08 BARS, 1.8 min)
TELEMETRY
TO ORBITER
PROBE MISSION TERMINATES
(~130 km, 20 BARS, 60 min TO
~150 km, 25 BARS, 75 min)

Spacecraft Scientific Activities

The Galileo mission and systems were designed to investigate three broad aspects of the Jupiter system: the planet's atmosphere, the satellites and the magnetosphere. The spacecraft is in three segments to focus on these areas: the atmospheric probe; a non-spinning section of the orbiter carrying cameras and other remote sensors; and the spinning main section of the orbiter spacecraft which includes the propulsion module, the communications antennas, main computers and most support systems as well as the fields and particles instruments, which sense and measure the environment directly as the spacecraft flies through it.

Probe Scientific Activities

The probe will enter the atmosphere about 6 degrees north of the equator. The probe weighs just under 750 pounds and includes a deceleration module to slow and protect the descent module, which carries out the scientific mission.

The deceleration module consists of an aeroshell and an aft cover designed to block the heat generated by slowing from the probe's arrival speed of about 115,000 miles per hour to subsonic speed in less than 2 minutes. After the covers are released, the descent module deploys its 8-foot parachute and its instruments, the control and data system, and the radio-relay transmitter go to work.

Operating at 128 bits per second, the dual L-band transmitters send nearly identical streams of scientific data to the orbiter. The probe's relay radio aboard the orbiter will have two redundant receivers that process probe science data, plus radio science and engineering data for transmission to the orbiter communications system. Minimum received signal strength is 31 dBm. The receivers also measure signal strength and Doppler shift as part of the experiments for measuring wind speeds and atmospheric absorption of radio signals.

Probe electronics are powered by long-life, high-discharge-rate 34-volt lithium batteries, which remain dormant for more than 5 years during the journey to Jupiter. The batteries have an estimated capacity of about 18 amp-hours on arrival at Jupiter.

Orbiter Scientific Activities

The orbiter, in addition to delivering the probe to Jupiter and relaying probe data to Earth, will support all the scientific investigations of Venus, the Earth and moon, asteroids and the interplanetary medium, Jupiter's satellites and magnetosphere, and observation of the giant planet itself.

The orbiter weighs about 5,200 pounds including about 2,400 pounds of rocket propellant to be expended in some 30 relatively small maneuvers during the long gravity-assisted flight to Jupiter, the large thrust maneuver which puts the craft into its Jupiter orbit, and the 30 or so trim maneuvers planned for the satellite tour phase.

The retropropulsion module consists of 12 10-newton thrusters, a single 400-newton engine, and the fuel, oxidizer, and pressurizing-gas tanks, tubing, valves and control equipment. (A thrust of 10 newtons would support a weight of about 2.2 pounds at Earth's surface). The propulsion system was developed and built by Messerschmitt-Bolkow-Blohm and provided by the Federal Republic of Germany.

The orbiter's maximum communications rate is 134 kilobits per second (the equivalent of about one black-and-white image per minute); there are other data rates, down to 10 bits per second, for transmitting engineering data under poor conditions. The spacecraft transmitters operate at S-band and X-band (2295 and 8415 megahertz) frequencies between Earth and on L-band between the probe.

The high-gain antenna is a 16-foot umbrella-like reflector unfurled after the first Earth flyby. Two low-gain antennas (one pointed forward and one aft, both mounted on the spinning section) are provided to support communications during the Earth-Venus-Earth leg of the flight and whenever the main antenna is not deployed and pointed at Earth. The despun section of the orbiter carries a radio relay antenna for receiving the probe's data transmissions.

Electrical power is provided to Galileo's equipment by two radioisotope thermoelectric generators. Heat produced by natural radioactive decay of plutonium 238 dioxide is converted to approximately 500 watts of electricity (570 watts at launch, 480 at the end of the mission) to operate the orbiter equipment for its 8-year active period. This is the same type of power source used by the Voyager and Pioneer Jupiter spacecraft in their long outer-planet missions, by the Viking lander spacecraft on Mars and the lunar scientific packages left on the Moon.

Most spacecraft are stabilized in flight either by spinning around a major axis or by maintaining a fixed orientation in space, referenced to the sun and another star. Galileo represents a hybrid of these techniques, with a spinning section rotating ordinarily at 3 rpm and a "despun" section which is counter-rotated to provide a fixed orientation for cameras and other remote sensors.

Instruments that measure fields and particles, together with the main antenna, the power supply, the propulsion module, most of the computers and control electronics, are mounted on the spinning section. The instruments include magnetometer sensors mounted on a 36-foot boom to escape interference from the spacecraft; a plasma instrument detecting low-energy charged particles and a plasma-wave detector to study waves generated in planetary magnetospheres and by lightning discharges; a high-energy particle detector; and a detector of cosmic and Jovian dust.

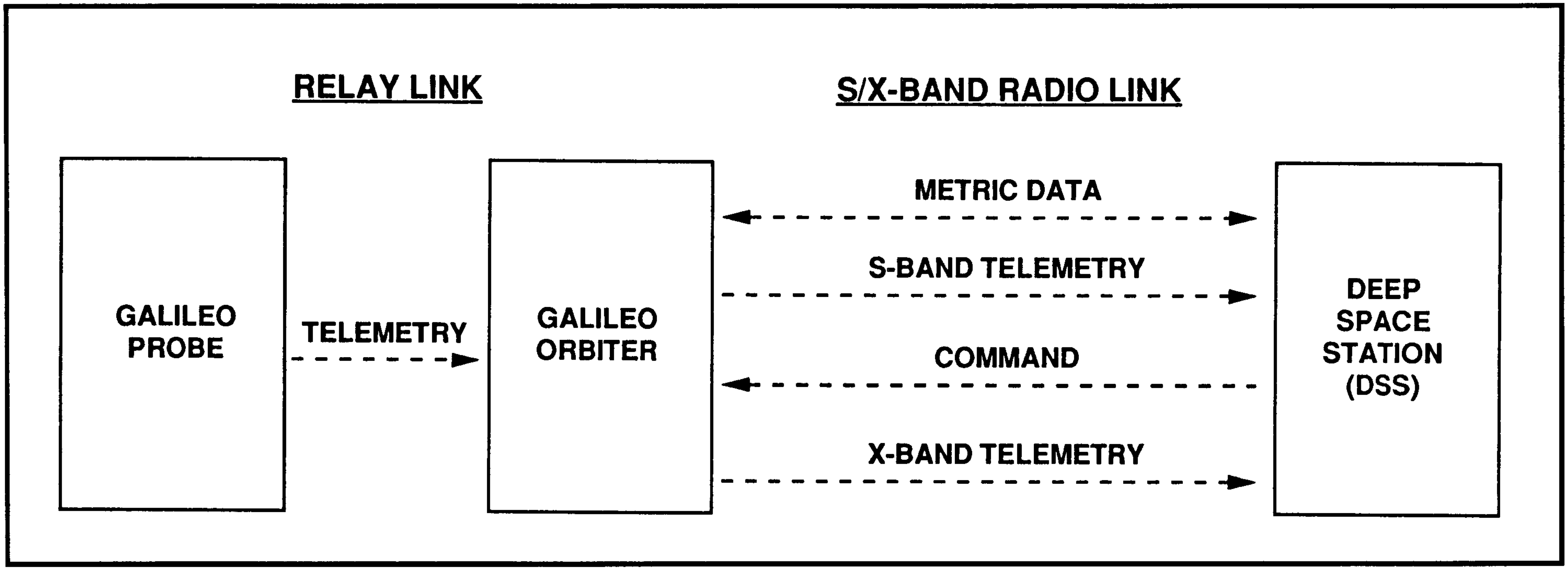
The despun section carries instruments and other equipment whose operation depends on a fixed orientation in space. The instruments include the camera system; the near-infrared mapping spectrometer to make multispectral images for atmosphere and surface chemical analysis; the ultraviolet spectrometer to study gases and ionized gases; and the photopolarimeter radiometer to measure radiant and reflected energy. The camera system is expected to obtain images of Jupiter's satellites at resolutions from 20 to 1,000 times better than Voyager's best.

This section also carries a dish antenna to track the probe in Jupiter's atmosphere and pick up its signals for relay to Earth. The probe is carried on the despun section, and before it is released, the whole spacecraft is spun up briefly to 10 rpm in order to spin-stabilize the probe.

The Galileo spacecraft will carry out its complex operations, including maneuvers, scientific observations and communications, in response to stored sequences which are interpreted and executed by various on-board computers. These sequences are sent up to the orbiter periodically through the Deep Space Network in the form of command loads.

GROUND SYSTEMS

Galileo communicates with Earth via NASA's Deep Space Network (DSN), which has a complex of large antennas with receivers and transmitters located in the California desert, another in Australia and a third in Spain, linked to a network control center at NASA's Jet Propulsion Laboratory in Pasadena, Calif. The spacecraft receives commands, sends science and engineering data, and is tracked by Doppler and ranging measurements through this network.



At JPL, about 275 scientists, engineers and technicians, will be supporting the mission at launch, increasing to nearly 400 for Jupiter operations including support from the German retropropulsion team at their control center in the FGR. Their responsibilities include spacecraft command, interpreting engineering and scientific data from Galileo to understand its performance, and analyzing navigation data from the DSN. The controllers use a set of complex computer programs to help them control the spacecraft and interpret the data.

Because the time delay in radio signals from Earth to Jupiter and back is more than an hour, the Galileo spacecraft was designed to operate from programs sent to it in advance and stored in spacecraft memory. A single master sequence program can cover 4 weeks of quiet operations between planetary and satellite encounters. During busy Jupiter operations, one program covers only a few days. Actual spacecraft tasks are carried out by several subsystems and scientific instruments, many of which work from their own computers controlled by the main sequence.

Designing these sequences is a complex process balancing the desire to make certain scientific observations with the need to safeguard the spacecraft and mission. The sequence design process itself is supported by software programs, for example, which display to the scientist maps of the instrument coverage on the surface of an approaching satellite for a given spacecraft orientation and trajectory. Notwithstanding these aids, a typical 3-day satellite encounter may take efforts spread over many months to design, check and recheck. The controllers also use software designed to check the command sequence further against flight rules and constraints.

The spacecraft regularly reports its status and health through an extensive set of engineering measurements. Interpreting these data into trends and averting or working around equipment failures is a major task for the mission operations team. Conclusions from this activity become an important input, along with scientific plans, to the sequence design process. This too is supported by computer programs written and used in the mission support area.

Navigation is the process of estimating, from radio range and Doppler measurements, the position and velocity of the spacecraft to predict its flight path and design course-correcting maneuvers. These calculations must be done with computer support. The Galileo mission, with its complex gravity-assist flight to Jupiter and 10 gravity-assist satellite encounters in the Jovian system, is extremely dependent on consistently accurate navigation.

In addition to the programs that directly operate the spacecraft and are periodically transmitted to it, the mission operations team uses software amounting to 650,000 lines of programming code in the sequence design process; 1,615,000 lines in the telemetry interpretation; and 550,000 lines of code in navigation. These must all be written, checked, tested, used in mission simulations and, in many cases, revised before the mission can begin.

Science investigators are located at JPL or other university laboratories and linked by computers. From any of these locations, the scientists can be involved in developing the sequences affecting their experiments and, in some cases, in helping to change preplanned sequences to follow up on unexpected discoveries with second looks and confirming observations.

JUPITER'S SYSTEM

Jupiter is the largest and fastest-spinning planet in the solar system. Its radius is more than 11 times Earth's, and its mass is 318 times that of our planet. Named for the chief of the Roman gods, Jupiter contains more mass than all the other planets combined. It is made mostly of light elements, principally hydrogen and helium. Its atmosphere and clouds are deep and dense, and a significant amount of energy is emitted from its interior.

SPACECRAFT CHARACTERISTICS

	Orbiter	Probe
Mass, lbs.	5,242	744
Propellant, lbs.	2,400	none
Height (in-flight)	15 feet	34 inches
Inflight span (w/o boom)	30 feet	
Instrument payload	10 instruments	6 instruments
Payload mass, lbs.	260	66
Electric power, watts	570-480 (RTGs)	730 (Lithium-sulfur battery)

The earliest Earth-based telescopic observations showed bands and spots in Jupiter's atmosphere. One storm system, the Red Spot, has been seen to persist over three centuries.

Atmospheric forms and dynamics were observed in increasing detail with the Pioneer and Voyager flyby spacecraft, and Earth-based infrared astronomers have recently studied the nature and vertical dynamics of deeper clouds.

Sixteen satellites are known. The four largest, discovered by the Italian scientist Galileo Galilei in 1610, are the size of small planets. The innermost of these, Io, has active sulfurous volcanoes, discovered by Voyager 1 and further observed by Voyager 2 and Earth-based infrared astronomy. Io and Europa are about the size and density of Earth's moon (3 to 4 times the density of water) and probably rocky inside. Ganymede and Callisto, further out from Jupiter, are the size of Mercury but less than twice as dense as water. Their cratered surfaces look icy in Voyager images, and they may be composed partly of ice or water.

Of the other satellites, eight (probably captured asteroids) orbit irregularly far from the planet, and four (three discovered by the Voyager mission in 1979) are close to the planet. Voyager also discovered a thin ring system at Jupiter in 1979.

Jupiter has the strongest planetary magnetic field known. The resulting magnetosphere is a huge teardrop-shaped, plasma-filled cavity in the solar wind pointing away from the sun. Jupiter's magnetosphere is the largest single entity in our solar system, measuring more than 14 times the diameter of the sun. The inner part of the magnetic field is doughnut- shaped, but farther out it flattens into a disk. The magnetic poles are offset and tilted relative to Jupiter's axis of rotation, so the field appears to wobble with Jupiter's rotation (just under 10 hours), sweeping up and down across the inner satellites and making waves throughout the magnetosphere.

WHY JUPITER INVESTIGATIONS ARE IMPORTANT

With a thin skin of turbulent winds and brilliant, swift-moving clouds, the huge sphere of Jupiter is a vast sea of liquid hydrogen and helium. Jupiter's composition (about 88 percent hydrogen and 11 percent helium with small amounts of methane, ammonia and water) is thought to resemble the makeup of the solar nebula, the cloud of gas and dust from which the sun and planets formed. Scientists believe Jupiter holds important clues to conditions in the early solar system and the process of planet formation.

Jupiter may also provide insights into the formation of the universe itself. Since it resembles the interstellar gas and dust that are thought to have been created in the "Big Bang," studies of Jupiter may help scientists calibrate models of the beginning of the universe.

Though starlike in composition, Jupiter is too small to generate temperatures high enough to ignite nuclear fusion, the process that powers the stars. Some scientists believe that the sun and Jupiter began as unequal partners in a binary star system. (If a double star system had developed, it is unlikely life could have arisen in the solar system.) While in a sense a "failed star," Jupiter is almost as large as a planet can be. If it contained more mass, it would not have grown larger, but would have shrunk from compression by its own gravity. If it were 100 times more massive, thermonuclear reactions would ignite, and Jupiter would be a star.

For a brief period after its formation, Jupiter was much hotter, more luminous, and about 10 times larger than it is now, scientists believe. Soon after accretion (the condensation of a gas and dust cloud into a planet), its brightness dropped from about one percent of the Sun's to about one billionth -- a decline of ten million times.

In its present state Jupiter emits about twice as much heat as it receives from the Sun. The loss of this heat -- residual energy left over from the compressive heat of accretion -- means that Jupiter is cooling and losing energy at a tremendously rapid rate. Temperatures in Jupiter's core, which were about 90,000 degrees Fahrenheit in the planet's hot, early phase, are now about 54,000 degrees Fahrenheit, 100 times hotter than any terrestrial surface, but 500 times cooler than the temperature at the center of the sun. Temperatures on Jupiter now range from 54,000 degrees Fahrenheit at the core to minus 248 degrees Fahrenheit at the top of the cloud banks.

Mainly uniform in composition, Jupiter's structure is determined by gradations in temperature and pressure. Deep in Jupiter's interior there is thought to be a small rocky core, comprising about four percent of the planet's mass. This "small" core (about the size of 10 Earths) is surrounded by a 25,000-mile-thick layer of liquid metallic hydrogen. (Metallic hydrogen is liquid, but sufficiently compressed to behave as metal.) Motions of this liquid "metal" are the source of the planet's enormous magnetic field. This field is created by the same dynamo effect found in the metallic cores of Earth and other planets.

At the outer limit of the metallic hydrogen layer, pressures equal three million times that of Earth's atmosphere and the temperature has cooled to 19,000 degrees Fahrenheit.

Surrounding the central metallic hydrogen region is an outer shell of "liquid" molecular hydrogen. Huge pressures compress Jupiter's gaseous hydrogen until, at this level, it behaves like a liquid. The liquid hydrogen layer extends upward for about 15,000 miles. Then it gradually becomes gaseous. This transition region between liquid and gas marks, in a sense, where the solid and liquid planet ends and its atmosphere begins.

From here, Jupiter's atmosphere extends up for 600 more miles, but only in the top 50 miles are found the brilliant bands of clouds for which Jupiter is known. The tops of these bands are colored bright yellow, red and orange from traces of phosphorous and sulfur. Five or six of these bands, counterflowing east and west, encircle the planet in each hemisphere. At one point near Jupiter's equator, east winds of 220 mph blow right next to west winds of 110 mph. At boundaries of these bands, rapid changes in wind speed and direction create large areas of turbulence and shear. These are the same forces that create tornados here on Earth. On Jupiter, these "baroclinic instabilities" are major phenomena, creating chaotic, swirling winds and spiral features such as White Ovals.

The brightest cloud banks, known as zones, are believed to be higher, cooler areas where gases are ascending. The darker bands, called belts, are thought to be warmer, cloudier regions of descent.

The top cloud layer consists of white cirrus clouds of ammonia crystals, at a pressure six-tenths that of Earth's atmosphere at sea level (.6 bar). Beneath this layer, at a pressure of about two Earth atmospheres (2 bars) and a temperature of near minus 160 degrees Fahrenheit, a reddish-brown cloud of ammonium hydrosulfide is predicted.

At a pressure of about 6 bars, there are believed to be clouds of water and ice. However, recent Earth-based spectroscopic studies suggest that there may be less water on Jupiter than expected. While scientists previously believed Jupiter and the sun would have similar proportions of water, recent work indicates there may be 100 times less water on Jupiter than if it had a solar mixture of elements. If this is the case, there may be only a thin layer of water-ice at the 6 bar level.

However, Jupiter's cloud structure, except for the highest layer of ammonia crystals, remains uncertain. The height of the lower clouds is still theoretical -- clouds are predicted to lie at the temperature levels where their assumed constituents are expected to condense. The Galileo probe will make the first direct observations of Jupiter's lower atmosphere and clouds, providing crucial information.

The forces driving Jupiter's fast-moving winds are not well understood yet. The classical explanation holds that strong currents are created by convection of heat from Jupiter's hot interior to the cooler polar regions, much as winds and ocean currents are driven on Earth, from equator to poles. But temperature differences do not fully explain wind velocities that can reach 265 mph. An alternative theory is that pressure differences, due to changes in the thermodynamic state of hydrogen at high and low temperatures, set up the wind jets.

Jupiter's rapid rotation rate is thought to have effects on wind velocity and to produce some of Jupiter's bizarre circulation patterns, including many spiral features. These rotational effects are known as manifestations of the Coriolis force. Coriolis force is what determines the spin direction of weather systems. It basically means that on the surface of a sphere (a planet), a parcel of gas farther from the poles has a higher rotational velocity around the planet than a parcel closer to the poles. As gases then move north or south, interacting parcels with different velocities produce vortices (whirlpools). This may account for some of Jupiter's circular surface features.

Jupiter spins faster than any planet in the solar system. Though 11 times Earth's diameter, Jupiter spins more than twice as fast (once in 10 hours), giving gases on the surface extremely high rates of travel -- 22,000 mph at the equator, compared with 1000 mph for air at Earth's equator. Jupiter's rapid spin also causes this gas and liquid planet to flatten markedly at the poles and bulge at the equator.

Visible at the top of Jupiter's atmosphere are eye-catching features such as the famous Great Red Spot and the exotic White Ovals, Brown Barges and White Plumes. The Great Red Spot, which is 25,000 miles wide and large enough to swallow three Earths, is an enormous oval eddy of swirling gases. It is driven by two counter-flowing jet streams, which pass, one on each side of it, moving in opposite directions, each with speeds of 100-200 mph. The Great Red Spot was first discovered in 1664, by the British scientist Roger Hook, using Galileo's telescope. In the three centuries since, the huge vortex has remained constant in latitude in Jupiter's southern equatorial belt. Because of its stable position, astronomers once thought it might be a volcano.

Another past theory compared the Great Red Spot to a gigantic hurricane. However, the GRS rotates anti-cyclonically while hurricanes are cyclonic features (counterclockwise in the northern hemisphere, clockwise in the southern) -- and the dynamics of the Great Red Spot appear unrelated to moisture.

The Great Red Spot most closely resembles an enormous tornado, a huge vortex that sucks in smaller vortices. The Coriolis effect created by Jupiter's fast spin, appears to be the key to the dynamics that drive the spot.

The source of the Great Red Spot's color remains a mystery. Many scientists now believe it to be caused by phosphorus, but its spectral line does not quite match that of phosphorus. The GRS may be the largest in a whole array of spiral phenomena with similar dynamics. About a dozen white ovals, circulation patterns resembling the GRS, exist in the southern latitudes of Jupiter and appear to be driven by the same forces. Scientists do not know why these ovals are white.

Scientists believe the brown barges, which appear like dark patches on the planet, are holes in the upper clouds, through which the reddish-brown lower cloud layer may be glimpsed. The equatorial plumes, or white plumes, may be a type of wispy cirrus anvil cloud.

GALILEO MANAGEMENT

The Galileo Project is managed for NASA's Office of Space Science and Applications by the NASA Jet Propulsion Laboratory, Pasadena, Calif. This responsibility includes designing, building, testing, operating and tracking Galileo. NASA's Ames Research Center, Moffett Field, Calif. is responsible for the atmosphere probe, which was built by Hughes Aircraft Company, El Segundo, Calif.

The probe project and science teams will be stationed at Ames during pre-mission, mission operations, and data reduction periods. Team members will be at Jet Propulsion Laboratory for probe entry.

The Federal Republic of Germany has furnished the orbiter's retropropulsion module and is participating in the scientific investigations. The radioisotope thermoelectric generators were designed and built for the U.S. Department of Energy by the General Electric Company.

GALILEO ORBITER AND PROBE SCIENTIFIC INVESTIGATIONS

Listed by experiment/instrument and including the Principal Investigator and scientific objectives of that investigation:

PROBE

Atmospheric Structure; A. Seiff, NASA's Ames Research Center; temperature, pressure, density, molecular weight profiles;

Neutral Mass Spectrometer; H. Niemann, NASA's Goddard Space Flight Center; chemical composition

Helium Abundance; U. von Zahn, Bonn University, FRG; helium/hydrogen ratio

Nephelometer; B. Ragent, NASA's Ames Research Center; clouds, solid/liquid particles

Net Flux Radiometer; L. Sromovsky, University of Wisconsin-Madison; thermal/solar energy profiles

Lightning/Energetic Particles; L. Lanzerotti, Bell Laboratories; detect lightning, measuring energetic particles

ORBITER (DESPUN PLATFORM)

Solid-State Imaging Camera; M. Belton, National Optical Astronomy Observatories (Team Leader); Galilean satellites at 1-km resolution or better

Near-Infrared Mapping Spectrometer; R. Carlson, NASA's Jet Propulsion Laboratory; surface/atmospheric composition, thermal mapping

Ultraviolet Spectrometer; C. Hord, University of Colorado; atmospheric gases, aerosols

Photopolarimeter Radiometer; J. Hansen, Goddard Institute for Space Studies; atmospheric particles, thermal/reflected radiation

ORBITER (SPINNING SPACECRAFT SECTION)

Magnetometer; M. Kivelson, University of California at Los Angeles; strength and fluctuations of magnetic fields

Energetic Particles; D. Williams, Johns Hopkins Applied Physics Laboratory; electrons, protons, heavy ions in magnetosphere and interplanetary space

Plasma; L. Frank, University of Iowa; composition, energy, distribution of magnetospheric ions

Plasma Wave; D. Gurnett, University of Iowa; electromagnetic waves and wave-particle interactions

Dust; E. Grun, Max Planck Institute; mass, velocity, charge of submicron particles

Radio Science - Celestial Mechanics; J. Anderson, JPL (Team Leader); masses and motions of bodies from spacecraft tracking;

Radio Science - Propagation; H. T. Howard, Stanford University; satellite radii, atmospheric structure both from radio propagation

INTERDISCIPLINARY INVESTIGATORS

F. P. Fanale; University of Hawaii

P. Gierasch; Cornell University

D. M. Hunten; University of Arizona

A. P. Ingersoll; California Institute of Technology

H. Masursky; U. S. Geological Survey

D. Morrison; Ames Research Center

M. McElroy; Harvard University

G. S. Orton; NASA's Jet Propulsion Laboratory

T. Owen; State University of New York, Stonybrook

J. B. Pollack; NASA's Ames Research Center

C. T Russell; University of California at Los Angeles

C. Sagan; Cornell University

G. Schubert; University of California at Los Angeles

J. Van Allen; University of Iowa

STS-34 INERTIAL UPPER STAGE (IUS-19)

The Inertial Upper Stage (IUS) will again be used with the Space Shuttle, this time to transport NASA's Galileo spacecraft out of Earth's orbit to Jupiter, a 2.5-billion-mile journey.

The IUS has been used previously to place three Tracking and Data Relay Satellites in geostationary orbit as well as to inject the Magellan spacecraft into its interplanetary trajectory to Venus. In addition, the IUS has been selected by the agency for the Ulysses solar polar orbit mission.

After 2 1/2 years of competition, Boeing Aerospace Co., Seattle, was selected in August 1976 to begin preliminary design of the IUS. The IUS was developed and built under contract to the Air Force Systems Command's Space Systems Division. The Space Systems Division is executive agent for all Department of Defense activities pertaining to the Space Shuttle system. NASA, through the Marshall Space Flight Center, Huntsville, Ala., purchases the IUS through the Air Force and manages the integration activities of the upper stage to NASA spacecraft.

Specifications

IUS-19, to be used on mission STS-34, is a two-stage vehicle weighing approximately 32,500 lbs. Each stage has a solid rocket motor (SRM), preferred over liquid-fueled engines because of SRM's relative simplicity, high reliability, low cost and safety.

The IUS is 17 ft. long and 9.25 ft. in diameter. It consists of an aft skirt, an aft stage SRM generating approximately 42,000 lbs. of thrust, an interstage, a forward-stage SRM generating approximately 18,000 lbs. of thrust, and an equipment support section.

Airborne Support Equipment

The IUS Airborne Support Equipment (ASE) is the mechanical, avionics and structural equipment located in the orbiter. The ASE supports the IUS and the Galileo in the orbiter payload bay and elevates the combination for final checkout and deployment from the orbiter.

The IUS ASE consists of the structure, electromechanical mechanisms, batteries, electronics and cabling to support the Galileo/IUS. These ASE subsystems enable the deployment of the combined vehicle; provide, distribute and/or control electrical power to the IUS and spacecraft; provide plumbing to cool the radioisotope thermoelectric generator (RTG) aboard Galileo; and serve as communication paths between the IUS and/or spacecraft and the orbiter.

IUS Structure

The IUS structure is capable of supporting loads generated internally and also by the cantilevered spacecraft during orbiter operations and the IUS free flight. It is made of aluminum skin-stringer construction, with longerons and ring frames.

Equipment Support Section

The top of the equipment support section contains the spacecraft interface mounting ring and electrical interface connector segment for mating and integrating the spacecraft with the IUS. Thermal isolation is provided by a multilayer insulation blanket across the interface between the IUS and Galileo.

The equipment support section also contains the avionics which provide guidance, navigation, control, telemetry, command and data management, reaction control and electrical power. All mission-critical components of the avionics system, along with thrust vector actuators, reaction control thrusters, motor igniter and pyrotechnic stage separation equipment are redundant to assure reliability of better than 98 percent.

IUS Avionics Subsystems

The avionics subsystems consist of the telemetry, tracking and command subsystems; guidance and navigation subsystem; data management; thrust vector control; and electrical power subsystems. These subsystems include all the electronic and electrical hardware used to perform all computations, signal conditioning, data processing and formatting associated with navigation, guidance, control, data and redundancy management. The IUS avionics subsystems also provide the equipment for communications between the orbiter and ground stations as well as electrical power distribution.

Attitude control in response to guidance commands is provided by thrust vectoring during powered flight and by reaction control thrusters while coasting. Attitude is compared with guidance commands to generate error signals. During solid motor firing, these commands gimble the IUS's movable nozzle to provide the desired pitch and yaw control. The IUS's roll axis thrusters maintain roll control. While coasting, the error signals are processed in the computer to generate thruster commands to maintain the vehicle's altitude or to maneuver the vehicle.

The IUS electrical power subsystem consists of avionics batteries, IUS power distribution units, a power transfer unit, utility batteries, a pyrotechnic switching unit, an IUS wiring harness and umbilical and staging connectors. The IUS avionics system provides 5-volt electrical power to the Galileo/IUS interface connector for use by the spacecraft telemetry system.

IUS Solid Rocket Motors

The IUS two-stage vehicle uses a large solid rocket motor and a small solid rocket motor. These motors employ movable nozzles for thrust vector control. The nozzles provide up to 4 degrees of steering on the large motor and 7 degrees on the small motor. The large motor is the longest-thrusting duration SRM ever developed for space, with the capability to thrust as long as 150 seconds. Mission requirements and constraints (such as weight) can be met by tailoring the amount of propellant carried. The IUS-19 first-stage motor will carry 21,488 lb. of propellant; the second stage 6,067 lb.

Reaction Control System

The reaction control system controls the Galileo/IUS spacecraft attitude during coasting, roll control during SRM thrustings, velocity impulses for accurate orbit injection and the final collision-avoidance maneuver after separation from the Galileo spacecraft.

As a minimum, the IUS includes one reaction control fuel tank with a capacity of 120 lb. of hydrazine. Production options are available to add a second or third tank. However, IUS-19 will require only one tank.

IUS To Spacecraft Interfaces

Galileo is physically attached to the IUS at eight attachment points, providing substantial load-carrying capability while minimizing the transfer of heat across the connecting points. Power, command and data transmission between the two are provided by several IUS interface connectors. In addition, the IUS provides a multilayer insulation blanket of aluminized Kapton with polyester net spacers across the Galileo/IUS interface, along with an aluminized Beta cloth outer layer. All IUS thermal blankets are vented toward and into the IUS cavity, which in turn is vented to the orbiter payload bay. There is no gas flow between the spacecraft and the IUS. The thermal blankets are grounded to the IUS structure to prevent electrostatic charge buildup.

Flight Sequence

After the orbiter payload bay doors are opened in orbit, the orbiter will maintain a preselected attitude to keep the payload within thermal requirements and constraints.

On-orbit predeployment checkout begins, followed by an IUS command link check and spacecraft communications command check. Orbiter trim maneuvers are normally performed at this time.

Forward payload restraints will be released and the aft frame of the airborne-support equipment will tilt the Galileo/IUS to 29 degrees. This will extend the payload into space just outside the orbiter payload bay, allowing direct communication with Earth during systems checkout. The orbiter then will be maneuvered to the deployment attitude. If a problem has developed within the spacecraft or IUS, the IUS and its payload can be restowed.

Prior to deployment, the spacecraft electrical power source will be switched from orbiter power to IUS internal power by the orbiter flight crew. After verifying that the spacecraft is on IUS internal power and that all Galileo/IUS predeployment operations have been successfully completed, a GO/NO-GO decision for deployment will be sent to the crew from ground support.

When the orbiter flight crew is given a "Go" decision, they will activate the ordnance that separates the spacecraft's umbilical cables. The crew then will command the electromechanical tilt actuator to raise the tilt table to a 58-degree deployment position. The orbiter's RCS thrusters will be inhibited and an ordnance-separation device initiated to physically separate the IUS/spacecraft combination from the tilt table.

Six hours, 20 minutes into the mission, compressed springs provide the force to jettison the IUS/Galileo from the orbiter payload bay at approximately 6 inches per second. The deployment is normally performed in the shadow of the orbiter or in Earth eclipse.

The tilt table then will be lowered to minus 6 degrees after IUS and its spacecraft are deployed. A small orbiter maneuver is made to back away from IUS/Galileo. Approximately 15 minutes after deployment, the orbiter's OMS engines will be ignited to move the orbiter away from its released payload.

After deployment, the IUS/Galileo is controlled by the IUS onboard computers. Approximately 10 minutes after IUS/Galileo deployment from the orbiter, the IUS onboard computer will send out signals used by the IUS and/or Galileo to begin mission sequence events. This signal will also enable the IUS reaction control system. All subsequent operations will be sequenced by the IUS computer, from transfer orbit injection through spacecraft separation and IUS deactivation.

After the RCS has been activated, the IUS will maneuver to the required thermal attitude and perform any required spacecraft thermal control maneuvers.

At approximately 45 minutes after deployment from the orbiter, the ordnance inhibits for the first SRM will be removed. The belly of the orbiter already will have been oriented towards the IUS/Galileo to protect orbiter windows from the IUS's plume. The IUS will recompute the first ignition time and maneuvers necessary to attain the proper attitude for the first thrusting period. When the proper transfer orbit opportunity is reached, the IUS computer will send the signal to ignite the first stage motor 60 minutes after deployment. After firing approximately 150 seconds, the IUS first stage will have expended its propellant and will be separated from the IUS second stage.

Approximately 140 seconds after first-stage burnout, the second- stage motor will be ignited, thrusting about 108 seconds. The IUS second stage then will separate and perform a final collision/contamination avoidance maneuver before deactivating.

SHUTTLE SOLAR BACKSCATTER ULTRAVIOLET INSTRUMENT

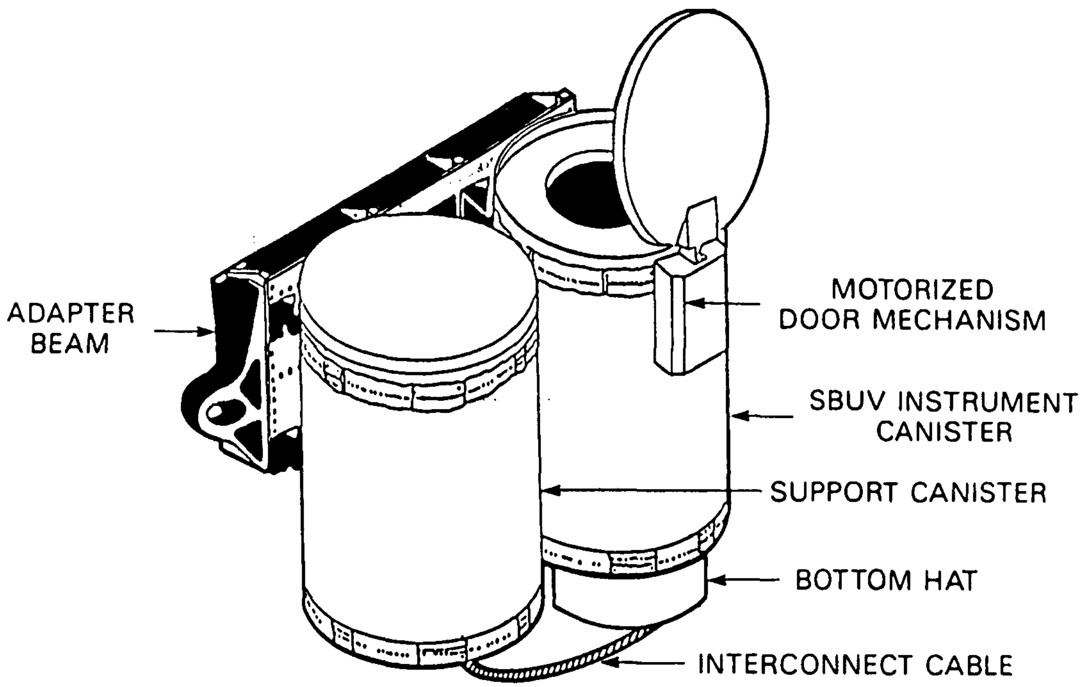
The Shuttle Solar Backscatter Ultraviolet (SSBUV) instrument was developed by NASA to calibrate similar ozone measuring space-based instruments on the National Oceanic and Atmospheric Administration's TIROS satellites (NOAA-9 and -11).

The SSBUV will help scientists solve the problem of data reliability caused by calibration drift of solar backscatter ultraviolet (SBUV) instruments on orbiting spacecraft. The SSBUV uses the Space Shuttle's orbital flight path to assess instrument performance by directly comparing data from identical instruments aboard the TIROS spacecraft, as the Shuttle and the satellite pass over the same Earth location within a 1-hour window. These orbital coincidences can occur 17 times per day.

The SBUV measures the amount and height distribution of ozone in the upper atmosphere. It does this by measuring incident solar ultraviolet radiation and ultraviolet radiation backscattered from the Earth's atmosphere. The SBUV measures these parameters in 12 discrete wavelength channels in the ultraviolet. Because ozone absorbs in the ultraviolet, an ozone measurement can be derived from the ratio of backscatter radiation at different wavelengths, providing an index of the vertical distribution of ozone in the atmosphere.

Global concern over the depletion of the ozone layer has sparked increased emphasis on developing and improving ozone measurement methods and instruments. Accurate, reliable measurements from space are critical to the detection of ozone trends and for assessing the potential effects and development of corrective measures.

SSBUV FLIGHT CONFIGURATION



The SSBUV missions are so important to the support of Earth science that six additional missions have been added to the Shuttle manifest for calibrating ozone instruments on future TIROS satellites. In addition, the dates of the four previously manifested SSBUV flights have been accelerated.

The SSBUV instrument and its dedicated electronics, power, data and command systems are mounted in the Shuttle's payload bay in two Get Away Special canisters, an instrument canister and a support canister. Together, they weigh approximately 1200 lb. The instrument canister holds the SSBUV, its specially designed aspect sensors and in-flight calibration system. A motorized door assembly opens the canister to allow the SSBUV to view the sun and Earth and closes during the in-flight calibration sequence.

The support canister contains the power system, data storage and command decoders. The dedicated power system can operate the SSBUV for a total of approximately 40 hours.

The SSBUV is managed by NASA's Goddard Space Flight Center, Greenbelt, Md. Ernest Hilsenrath is the principal investigator.

GROWTH HORMONE CONCENTRATIONS AND DISTRIBUTION IN PLANTS

The Growth Hormone Concentration and Distribution in Plants (GHCD) experiment is designed to determine the effects of microgravity on the concentration, turnover properties, and behavior of the plant growth hormone, Auxin, in corn shoot tissue (Zea Mays).

Mounted in foam blocks inside two standard middeck lockers, the equipment consists of four plant cannisters, two gaseous nitrogen freezers and two temperature recorders. Equipment for the experiment, excluding the lockers, weighs 97.5 pounds.

A total of 228 specimens (Zea Mays seeds) are "planted" in special filter, paper-Teflon tube holders no more than 56 hours prior to flight. The seeds remain in total darkness throughout the mission.

The GHCD experiment equipment and specimens will be prepared in a Payload Processing Facility at KSC and placed in the middeck lockers. The GHCD lockers will be installed in the orbiter middeck within the last 14 hours before launch.

No sooner than 72 hours after launch, mission specialist Ellen Baker will place two of the plant cannisters into the gaseous nitrogen freezers to arrest the plant growth and preserve the specimens. The payload will be restowed in the lockers for the remainder of the mission.

After landing, the payload must be removed from the orbiter within 2 hours and will be returned to customer representatives at the landing site. The specimens will be examined post flight for microgravity effects.

The GHCD experiment is sponsored by NASA Headquarters, the Johnson Space Center and Michigan State University.

POLYMER MORPHOLOGY

The Polymer Morphology (PM) experiment is a 3M-developed organic materials processing experiment designed to explore the effects of microgravity on polymeric materials as they are processed in space.

Since melt processing is one of the more industrially significant methods for making products from polymers, it has been chosen for study in the PM experiment. Key aspects of melt processing include polymerization, crystallization and phase separation. Each aspect will be examined in the experiment. The polymeric systems for the first flight of PM include polyethelyne, nylon-6 and polymer blends.

The apparatus for the experiment includes a Fournier transform infrared (FTIR) spectrometer, an automatic sample manipulating system and a process control and data acquisition computer known as the Generic Electronics Module (GEM). The experiment is contained in two separate, hermetically sealed containers that are mounted in the middeck of the orbiter. Each container includes an integral heat exchanger that transfers heat from the interior of the containers to the orbiter's environment. All sample materials are kept in triple containers for the safety of the astronauts.

The PM experiment weighs approximately 200 lb., occupies three standard middeck locker spaces (6 cubic ft., total) in the orbiter and requires 240 watts to operate.

Mission specialists Franklin R. Chang-Diaz and Shannon W. Lucid are responsible for the operation of the PM experiment on orbit. Their interface with the PM experiment is through a small, NASA-supplied laptop computer that is used as an input and output device for the main PM computer. This interface has been programmed by 3M engineers to manage and display the large quantity of data that is available to the crew. The astronauts will have an active role in the operation of the experiment.

In the PM experiment, infrared spectra (400 to 5000 cm-1) will be acquired from the FTIR by the GEM computer once every 3.2 seconds as the materials are processed on orbit. During the 100 hours of processing time, approximately 2 gigabytes of data will be collected. Post flight, 3M scientists will process the data to reveal the effects of microgravity on the samples processed in space.

The PM experiment is unique among material processing experiments in that measurements characterizing the effects of microgravity will be made in real time, as the materials are processed in space.

In most materials processing space experiments, the materials have been processed in space with little or no measurements made during on-orbit processing and the effects of microgravity determined post facto.

The samples of polymeric materials being studied in the PM experiment are thin films (25 microns or less) approximately 25 mm in diameter. The samples are mounted between two infrared transparent windows in a specially designed infrared cell that provides the capability of thermally processing the samples to 200 degrees Celsius with a high degree of thermal control. The samples are mounted on a carousel that allows them to be positioned, one at a time, in the infrared beam where spectra may be acquired. The GEM provides all carousel and sample cell control. The first flight of PM will contain 17 samples.

The PM experiment is being conducted by 3M's Space Research and Applications Laboratory. Dr. Earl L. Cook is 3M's Payload Representative and Mission Coordinator. Dr. Debra L. Wilfong is PM's Science Coordinator, and James E. Steffen is the Hardware Coordinator.

The PM experiment, a commercial development payload, is sponsored by NASA's Office of Commercial Programs. The PM experiment will be 3M's fifth space experiment and the first under the company's 10-year Joint Endeavor Agreement with NASA for 62 flight experiment opportunities. Previous 3M space experiments have studied organic crystal growth from solution (DMOS/1 on mission STS 51-A and DMOS/2 on STS 61-B) and organic thin film growth by physical vapor treatment (PVTOS/1 on STS 51-I and PVTOS/2 on mission STS-26).

STUDENT EXPERIMENT

Zero Gravity Growth of Ice Crystals From Supercooled Water With Relation To Temperature (SE82-15)

This experiment, proposed by Tracy L. Peters, formerly of Ygnacio High School, Concord, Calif., will observe the geometric ice crystal shapes formed at supercooled temperatures, below 0 degrees Celsius, without the influence of gravity.

Liquid water has been discovered at temperatures far below water's freezing point. This phonomenon occurs because liquid water does not have a nucleus, or core, around which to form the crystal. When the ice freezes at supercold temperatures, the ice takes on many geometric shapes based on the hexagon. The shape of the crystal primarily depends on the supercooled temperature and saturation of water vapor. The shapes of crystals vary from simple plates to complex prismatic crystals.

Many scientists have tried to determine the relation between temperature and geometry, but gravity has deformed crystals, caused convection currents in temperature-controlled apparatus, and caused faults in the crystalline structure. These all affect crystal growth by either rapid fluctuations of temperature or gravitational influence of the crystal geometry.

The results of this experiment could aid in the design of radiator cooling and cryogenic systems and in the understanding of high-altitude meteorology and planetary ring structure theories.

Peters is now studying physics at the University of California at Berkeley. His teacher advisor is James R. Cobb, Ygnacio High School; his sponsor is Boeing Aerospace Corp., Seattle.

Peters also was honored as the first four-time NASA award winner at the International Science and Engineering Fair (ISEF), which recognizes student's creative scientific endeavors in aerospace research. At the 1982 ISEF, Peters was one of two recipients of the Glen T. Seaborg Nobel Prize Visit Award, an all-expense-paid visit to Stockholm to attend the Nobel Prize ceremonies, for his project "Penetration and Diffusion of Supersonic Fluid."

MESOSCALE LIGHTNING EXPERIMENT

The Space Shuttle will again carry the Mesoscale Lightning Experiment (MLE), designed to obtain nighttime images of lightning in order to better understand the global distribution of lightning, the interrelationships between lightning events in nearby storms, and relationships between lightning, convective storms and precipitation.

A better understanding of the relationships between lightning and thunderstorm characteristics can lead to the development of applications in severe storm warning and forecasting, and early warning systems for lightning threats to life and property.

In recent years, NASA has used both Space Shuttle missions and high-altitude U-2 aircraft to observe lightning from above convective storms. The objectives of these observations have been to determine some of the baseline design requirements for a satellite-borne optical lightning mapper sensor; study the overall optical and electrical characteristics of lightning as viewed from above the cloudtop; and investigate the relationship between storm electrical development and the structure, dynamics and evolution of thunderstorms and thunderstorm systems.

The MLE began as an experiment to demonstrate that meaningful, qualitative observations of lightning could be made from the Shuttle. Having accomplished this, the experiment is now focusing on quantitative measurements of lightning characteristics and observation simulations for future space-based lightning sensors.

Data from the MLE will provide information for the development of observation simulations for an upcoming polar platform and Space Station instrument, the Lightning Imaging Sensor (LIS). The lightning experiment also will be helpful for designing procedures for using the Lightning Mapper Sensor (LMS), planned for several geostationary platforms.

In this experiment, Atlantis' payload bay camera will be pointed directly below the orbiter to observe nighttime lightning in large, or mesoscale, storm systems to gather global estimates of lightning as observed from Shuttle altitudes. Scientists on the ground will analyze the imagery for the frequency of lightning flashes in active storm clouds within the camera's field of view, the length of lightning discharges, and cloud brightness when illuminated by the lightning discharge within the cloud.

If time permits during missions, astronauts also will use a handheld 35mm camera to photograph lightning activity in storm systems not directly below the Shuttle's orbital track.

Data from the MLE will be associated with ongoing observations of lightning made at several locations on the ground, including observations made at facilities at the Marshall Space Flight Center, Huntsville, Ala.; Kennedy Space Center, Fla.; and the NOAA Severe Storms Laboratory, Norman, Okla. Other ground-based lightning detection systems in Australia, South America and Africa will be intergrated when possible.

The MLE is managed by the Marshall Space Flight Center. Otha H. Vaughan Jr., is coordinating the experiment. Dr. Hugh Christian is the project scientist, and Dr. James Arnold is the project manager.

IMAX

The IMAX project is a collaboration between NASA and the Smithsonian Institution's National Air and Space Museum to document significant space activities using the IMAX film medium. This system, developed by the IMAX Systems Corp., Toronto, Canada, uses specially designed 70mm film cameras and projectors to record and display very high definition large-screen color motion pictures.

IMAX cameras previously have flown on Space Shuttle missions 41-C, 41-D and 41-G to document crew operations in the payload bay and the orbiter's middeck and flight deck along with spectacular views of space and Earth.

Film from those missions form the basis for the IMAX production, "The Dream is Alive." On STS 61-B, an IMAX camera mounted in the payload bay recorded extravehicular activities in the EAS/ACCESS space construction demonstrations.

The IMAX camera, most recently carried aboard STS-29, will be used on this mission to cover the deployment of the Galileo spacecraft and to gather material on the use of observations of the Earth from space for future IMAX films.

AIR FORCE MAUI OPTICAL SITE CALIBRATION TEST

The Air Force Maui Optical Site (AMOS) tests allow ground-based electro-optical sensors located on Mt. Haleakala, Maui, Hawaii, to collect imagery and signature data of the orbiter during cooperative overflights. Scientific observations made of the orbiter while performing Reaction Control System thruster firings, water dumps or payload bay light activation are used to support the calibration of the AMOS sensors and the validation of spacecraft contamination models. AMOS tests have no payload-unique flight hardware and only require that the orbiter be in predefined attitude operations and lighting conditions.

The AMOS facility was developed by Air Force Systems Command (AFSC) through its Rome Air Development Center, Griffiss Air Force Base, N.Y., and is administered and operated by the AVCO Everett Research Laboratory, Maui. The principal investigator for the AMOS tests on the Space Shuttle is from AFSC's Air Force Geophysics Laboratory, Hanscom Air Force Base, Mass. A co-principal investigator is from AVCO.

Flight planning and mission support activities for the AMOS test opportunities are provided by a detachment of AFSC's Space Systems Division at Johnson Space Center, Houston. Flight operations are conducted at JSC Mission Control Center in coordination with the AMOS facilities located in Hawaii.

SENSOR TECHNOLOGY EXPERIMENT

The Sensor Technology Experiment (STEX) is a radiation detection experiment designed to measure the natural radiation background. The STEX is a self-contained experiment with its own power, sensor, computer control and data storage. A calibration pack, composed of a small number of passive threshold reaction monitors, is attached to the outside of the STEX package.

Sponsored by the Strategic Defense Initiative Organization, the STEX package weighs approximately 50 pounds and is stowed in a standard middeck locker throughout the flight.

PAYLOAD AND VEHICLE WEIGHTS

Vehicle/Payload	Weight (Pounds)
Orbiter (Atlantis) Empty	172,018
Galileo/IUS (payload bay)	43,980
Galileo support hardware (middeck)	59
SSBUV (payload bay)	637
SSBUV support	578
DSO	49
DTO	170
GHCD	130
IMAX	269
MLE	15
PM	219
SSIP	70
STEX	52
Orbiter and Cargo at SRB Ignition	264,775
Total Vehicle at SRB Ignition	4,523,810
Orbiter Landing Weight	195,283

SPACEFLIGHT TRACKING AND DATA NETWORK

Primary communications for most activities on STS-34 will be conducted through the orbiting Tracking and Data Relay Satellite System (TDRSS), a constellation of three communications satellites in geosynchronous orbit 22,300 miles above the Earth. In addition, three NASA Spaceflight Tracking and Data Network (STDN) ground stations and the NASA Communications Network (NASCOM), both managed by Goddard Space Flight Center, Greenbelt, Md., will play key roles in the mission.

Three stations -- Merritt Island and Ponce de Leon, Florida and the Bermuda -- serve as the primary communications during the launch and ascent phases of the mission. For the first 80 seconds, all voice, telemetry and other communications from the Space Shuttle are relayed to the mission managers at Kennedy and Johnson Space Centers by way of the Merritt Island facility.

At 80 seconds, the communications are picked up from the Shuttle and relayed to the two NASA centers from the Ponce de Leon facility, 30 miles north of the launch pad. This facility provides the communications between the Shuttle and the centers for 70 seconds, or until 150 seconds into the mission. This is during a critical period when exhaust from the solid rocket motors "blocks out" the Merritt Island antennas.

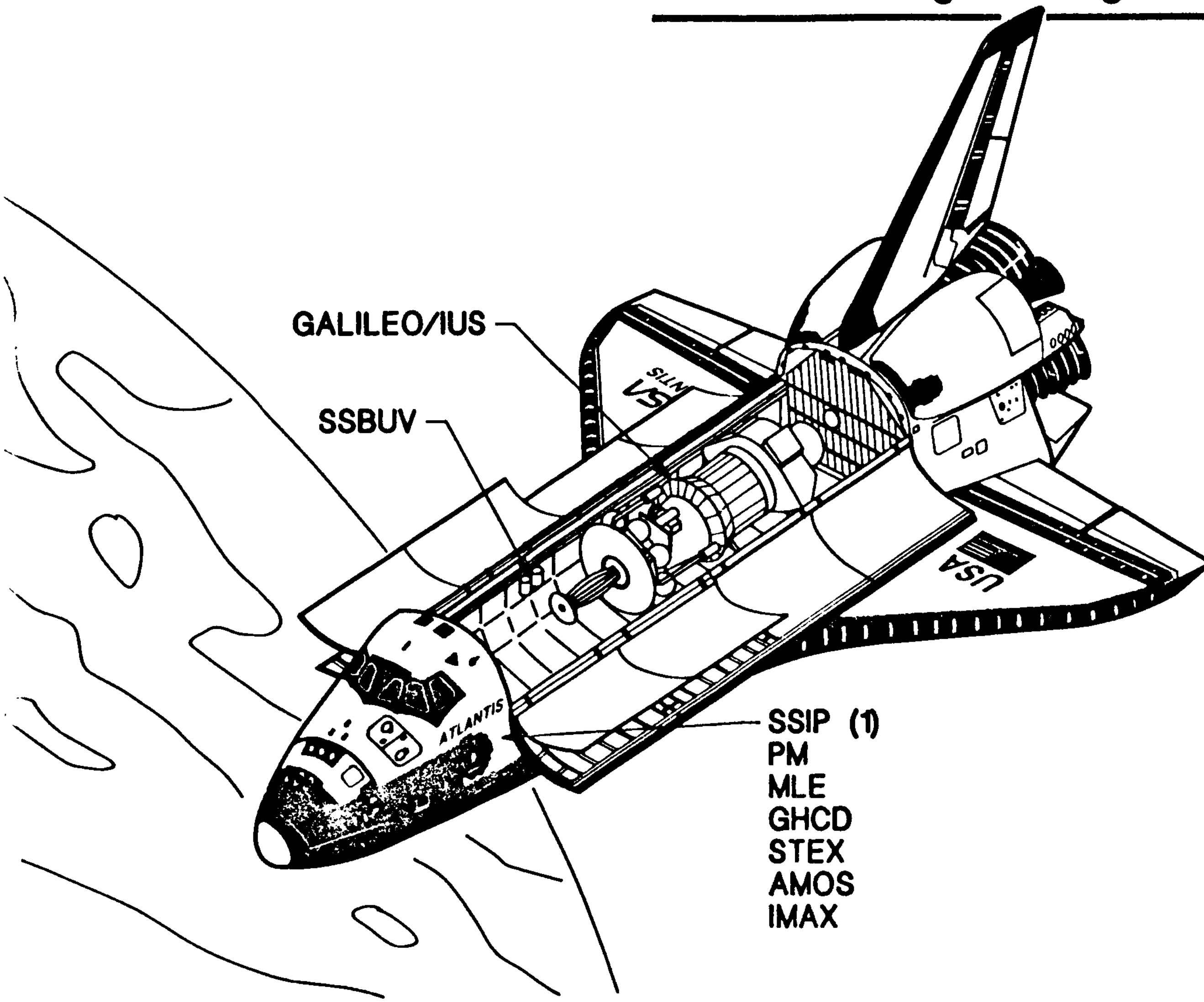
The Merritt Island facility resumes communications to and from the Shuttle after those 70 seconds and maintains them until 6 minutes, 30 seconds after launch when communications are "switched over" to Bermuda. Bermuda then provides the communications until 11 minutes after liftoff when the TDRS-East satellite acquires the Shuttle. TDRS-West acquires the orbiter at launch plus 50 minutes.

The TDRS-East and -West satellites will provide communications with the Shuttle during 85 percent or better of each orbit. The TDRS-West satellite will handle communications with the Shuttle during its descent and landing phases.

NASA

C907847C.ART;8

National STS Program
STS-34 Cargo Configuration



CREW BIOGRAPHIES

Donald E. Williams, 47, Capt., USN, will serve as commander. Selected as an astronaut in January 1978, he was born in Lafayette, Ind.

Williams was pilot for STS-51D, the fourth flight of Discovery, launched April 12, 1985. During the mission, the seven-member crew deployed the Anik-C communications satellite for Telesat of Canada and the Syncom IV-3 satellite for the U.S. Navy. A malfunction in the Syncom spacecraft resulted in the first unscheduled extravehicular, rendezvous and proximity operation for the Space Shuttle in an attempt to activate the satellite.

He graduated from Otterbein High School, Otterbein, Ind., in 1960 and received his B.S. degree in mechanical engineering from Purdue University in 1964. Williams completed his flight training at Pensacola, Fla., Meridian, Miss., and Kingsville, Texas, and earned his wings in 1966.

During the Vietnam Conflict, Williams completed 330 combat missions. He has logged more than 5,400 hours flying time, including 5,100 in jets, and 745 aircraft carrier landings.

Michael J. McCulley, 46, Cdr., USN, will be pilot on this flight. Born in San Diego, McCulley considers Livingston, Tenn., his hometown. He was selected as a NASA astronaut in 1984. He is making his first Space Shuttle flight.

McCulley graduated from Livingston Academy in 1961. He received B.S. and M.S. degrees in metallurgical engineering from Purdue University in 1970.

After graduating from high school, McCulley enlisted in the U.S. Navy and subsequently served on one diesel-powered and two nuclear-powered submarines. Following flight training, he served tours of duty in A-4 and A-65 aircraft and was selected to attend the Empire Test Pilots School in Great Britain. He served in a variety of test pilot billets at the Naval Air Test Center, Patuxent River, Md., before returning to sea duty on the USS Saratoga and USS Nimitz.

He has flown more than 50 types of aircraft, logging more than 4,760 hours, and has almost 400 carrier landings on six aircraft carriers.

Shannon W. Lucid, 46, will serve as mission specialist (MS-1) on this, her second Shuttle flight. Born in Shanghai, China, she considers Bethany, Okla., her hometown. Lucid is a member of the astronaut class of 1978.

Lucid's first Shuttle mission was during STS 51-G, launched from the Kennedy Space Center on June 17, 1985. During that flight, the crew deployed communications satellites for Mexico, the Arab League and the United States.

Lucid graduated from Bethany High School in 1960. She then attended the University of Oklahoma where she received a B.S. degree in chemistry in 1963, an M.S. degree in biochemistry in 1970 and a Ph.D. in biochemistry in 1973.

Before joining NASA, Lucid held a variety of academic assignments such as teaching assistant at the University of Oklahoma's department of chemistry; senior laboratory technician at the Oklahoma Medical Research Foundation; chemist at Kerr-McGee in Oklahoma City; graduate assistant in the University of Oklahoma Health Science Center's department of biochemistry; and molecular biology and research associate with the Oklahoma Medical Research Foundation in Oklahoma City. Lucid also is a commercial, instrument and multi-engine rated pilot.

Franklin Chang-Diaz, 39, will serve as MS-2. Born in San Jose, Costa Rica, Chang-Diaz also will be making his second flight since being selected as an astronaut in 1980.

Chang-Diaz made his first flight aboard Columbia on mission STS 61-C, launched from KSC Jan. 12, 1986. During the 6-day flight he participated in the deployment of the SATCOM KU satellite, conducted experiments in astrophysics and operated the materials science laboratory, MSL-2.

Chang-Diaz graduated from Colegio De La Salle, San Jose, Costa Rica, in 1967, and from Hartford High School, Hartford, Conn., in 1969. He received a B.S. degree in mechanical engineering from the University of Connecticut in 1973 and a Ph.D. in applied plasma physics from the Massachusetts Institute of Technology in 1977.

While attending the University of Connecticut, Chang-Diaz also worked as a research assistant in the physics department and participated in the design and construction of high-energy atomic collision experiments. Upon entering graduate school at MIT, he became heavily involved in the United State's controlled fusion program and conducted intensive research in the design and operation of fusion reactors. In 1979, he developed a novel concept to guide and target fuel pellets in an inertial fusion reactor chamber. In 1983, he was appointed as visiting scientist with the MIT Plasma Fusion Center which he visits periodically to continue his research on advanced plasma rockets.

Chang-Diaz has logged more than 1,500 hours of flight time, including 1,300 hours in jet aircraft.

Ellen S. Baker, 36, will serve as MS-3. She will be making her first Shuttle flight. Baker was born in Fayetteville, N.C., and was selected as an astronaut in 1984.

Baker graduated from Bayside High School, New York, N.Y., in 1970. She received a B.A. degree in geology from the State University of New York at Buffalo in 1974, and an M.D. from Cornell University in 1978.

After medical school, Baker trained in internal medicine at the University of Texas Health Science Center in San Antonio, Texas. In 1981, she was certified by the American Board of Internal Medicine.

Baker joined NASA as a medical officer at the Johnson Space Center in 1981 after completing her residency. That same year, she graduated with honors from the Air Force Aerospace Medicine Primary Course at Brooks Air Force Base in San Antonio. Prior to her selection as an astronaut, she served as a physician in the Flight Medicine Clinic at JSC.

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For Release:
October 2, 1989

RELEASE: 89-155

MOOREHEAD NAMED SPACE STATION FREEDOM PROGRAM DEPUTY

Richard H. Kohrs, Director, Space Station Freedom, announced today that Robert W. Moorehead will serve as the Deputy Director, Program and Operations, Space Station Freedom Program Office.

James M. Sisson, who has been acting Deputy Director since June, will assume the position of Deputy Manager, Space Station Freedom Program and Operations.

Moorehead is special assistant on the staff of the Director of the Johnson Space Center, Houston, and before that was Manager, NSTS Engineering Integration Office at the Johnson Space Center (JSC), Houston.

As Deputy Director, Program and Operations, Moorehead will direct the space station program office, located in Reston, Va., which is responsible for the overall technical direction and content of the international space complex, including systems engineering and analysis and configuration management, budgeting and schedules.

Moorehead was born in Hickory Flat, Miss. He received a bachelor of science degree in electrical engineering from Mississippi State University and a master of science degree in electrical engineering from the University of Southern California and has done graduate work at the University of Houston.

Moorehead has served in various capacities since joining NASA in 1964, including Deputy Manager, Space Transportation System Orbiter and Government Furnished Equipment Projects Office and Manager, Avionics Systems Office at JSC.

He is a member of numerous civic and professional engineering societies and has received a number of NASA awards, including the NASA Special Achievement Award, the NASA Exceptional Service Medal and the NASA Outstanding Leadership Medal in 1988.

-end-

NASA News

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For Release:
October 2, 1989

RELEASE: 89-156

GEYSER-LIKE PLUME DISCOVERED ON NEPTUNE'S MOON TRITON

A 5-mile-tall, geyser-like plume of dark material has been discovered erupting from the surface of Neptune's moon Triton in images returned last month to the Jet Propulsion Laboratory, Pasadena, Calif., by NASA's Voyager 2 spacecraft.

The discovery comes just as the Neptune encounter -- Voyager 2's fourth and final planetary flyby in 12 years -- officially ends today, Oct. 2.

This is the first time geyser-like phenomena have been seen on any solar system object, other than Earth, since Voyager discovered eight active geysers shooting sulfur above the surface of Jupiter's moon, Io. The new finding -- Voyager's last hurrah in its journey past the planets -- augments Triton's emerging reputation as the most perplexing of all the dozens of moons Voyagers 1 and 2 have explored.

Voyager 2's camera captured the eruption shooting dark particles high into Triton's thin atmosphere. Resembling a smokestack, the narrow stem of the dark plume, measured using stereo images, rises vertically nearly 5 miles and forms a cloud that drifts 90 miles westward in Triton's winds.

While Voyager scientists are trying to determine the mechanism responsible for the eruption, one possibility being considered is that pressurized gas, probably nitrogen, rises from beneath the surface and carries aloft dark particles and possibly ice crystals. Whatever the cause, the plume takes the particles to an altitude where they are left suspended to form a cloud that drifts westward.

- more -

Voyager 2's working life among the planets may be at an end, but the spacecraft and its twin, Voyager 1, are expected to continue returning information about the various fields and particles they encounter while approaching and eventually crossing the boundary of our solar system. The plutonium-based generators that provide electricity to the spacecraft are expected to keep alive the computers, science instruments and radio transmitter for up to 25 or 30 more years.

As of today, the long-lived project will be known as the Voyager Interstellar Mission. The Voyager Project is managed for NASA's Office of Space Science And Applications by the Jet Propulsion Laboratory, Pasadena, Calif.

- end -

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For Release:
4 p.m. EDT
October 3, 1989

RELEASE: C89-X

BALL CORP. SELECTED FOR SPACE FLIGHT INSTRUMENTS CONTRACT

NASA Langley Research Center, Hampton, Va., has selected Ball Corp., Boulder, Colo., for negotiation of a contract to develop three space flight instruments for the NASA polar orbiting platform and the manned Space Station Freedom as part of the Earth observing system (Eos). The goal of Eos, a new start candidate for fiscal year 1991, is to advance scientific understanding of the Earth's land masses, oceans and atmosphere; the interactions among them; and how the Earth's system is changing.

The two-phase contract has an estimated value of $23 million. Phase one, a cost-plus-fixed-fee contract, is for 1 year and has an estimated value of $300,000. The contract will be effective Nov. 1, 1989. Phase two, which would begin after Eos new start approval, is a cost-plus-award-fee option. It would be for 10 years and has an estimated value of $22.7 million. The work will be performed by the Ball Electro-Optics/ Cryogenics Div., Boulder.

The three space flight instruments, known as SAGE III (Stratospheric Aerosol and Gas Experiment), are expected to provide vertical resolution profiles of aerosols and other atmospheric gases from near the Earth's surface or cloud tops into the stratosphere and mesosphere.

The SAGE III instruments are automated space flight instruments consisting of a telescope, spectrometer, scanning system and solar signal detection system with accompanying electronic command and controls, optical subsystems and data collection subsystems. They will provide additional wavelengths allowing the measurement of more atmospheric constituents, increased resolution and improved altitude range. This will result in more scientific data per measurement than previous SAGE experiments.

Ball Corp. will design, fabricate and deliver the SAGE III instruments and provide support for integration, launch, flight operations and on-orbit servicing for the designated missions.

-end-

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For Release:
October 3, 1989

RELEASE: C89-Y

NASA AWARDS AVIONICS ENGINEERING CONTRACT TO DRAPER LABORATORY

NASA's Johnson Space Center (JSC), Houston, has signed a contract with The Charles Stark Draper Laboratory, Cambridge, Mass., for avionics systems engineering and analysis support. The work will take place at contractor facilities located adjacent to JSC and at Cambridge, Mass.

The total estimated value of the 3-year, cost-plus-fixed-fee, level-of-effort contract is $25,128,996. The estimated value of the 2-year basic period of May 1, 1989 through April 30, 1991 is $17,113,140. The estimated value of the 1-year priced option, from May 1, 1991 through April 30, 1992, is $8,015,856.

Draper Laboratory will provide engineering support and verification of the Space Shuttle avionics system as well as engineering assessment of Space Station Freedom guidance, navigation and control (GN&C) system and information system.

The contracted efforts also include research and development in GN&C systems for advanced spacecraft, both manned and unmanned, and related design activities for NASA technology initiatives.

The effort was contracted for on a sole-source basis, based on the exception to competition article 10 U.S.C. 2304(3).

- end -

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For Release:
October 3, 1989

RELEASE: C89-Z

HONEYWELL AWARDED COMPUTER MAINTENENCE CONTRACT

NASA's John F. Kennedy Space Center (KSC), Fla., has awarded a contract for computer maintenance to Honeywell Federal Systems, Inc., McLean, Va.

The 1-year contract, valued at $6,105,545, covers the period Oct. 1, 1989 through Sept. 30, 1990 and contains four 1-year options for services through fiscal year 1994. Total value of the contract, if all options are exercised, is $35,818,917.

The contract will provide for hardware maintenance, software licenses and on-site systems analysts for Honeywell computer systems used at KSC for Space Shuttle launch processing, payload processing and base operations inventory data bases.

These services have been provided to KSC by Honeywell Federal Systems, Inc., since 1975.

\- end -

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For Release:
October 3, 1989

RELEASE: 89-157

NASA SEEKS SPACE STATION ASSURED CREW RETURN VEHICLE PROPOSALS

NASA today released a request for proposals (RFP) for definition studies of a new vehicle that would serve as a lifeboat for Space Station Freedom, providing the capability for assured crew return from space. Deadline for proposal submission is Nov. 16, 1989.

The Assured Crew Return Capability (ACRC) System is conceptualized as a vehicle, continuously berthed at Space Station Freedom, for crew return to Earth in event of a medical emergency or other contingencies which cannot be supported by the Space Shuttle, for any reason, including grounding of the Shuttle fleet.

The RFP encourages the use of existing technologies for a simple and reliable ACRC vehicle. ACRC necessitates that a vehicle be berthed at the station for immediate use and be reliable enough to be maintained at Freedom for long periods of time before use.

Since the beginning of the manned space program, NASA has been dedicated to assured crew return capability for its space vehicles. In the Mercury and Gemini program flights, the first orbit's trajectory assured the return of the spacecraft. Apollo missions were flown on lunar "free return" trajectories where the spacecraft could circle the Moon and return to Earth automatically. During Skylab missions, an Apollo spacecraft was docked at the facility whenever crewmembers were aboard.

NASA will award two parallel contracts providing for a $1.5 million, 6-month effort to prepare final ACRC system requirements, to assess feasible configurations and to examine cost, risks and schedules.

- more -

The contracts also will include an option, valued at $4.5 million, which, if exercised, will provide for systems definition and preliminary design of the ACRC system. The contracts (basic contracts plus options), with a potential value of $6 million each, will support efforts leading to initiation of full-scale development of a vehicle in 1992.

The definition studies will be managed by NASA's Johnson Space Center, Houston.

- end -

EDITORS NOTE: The Assured Crew Return RFP is available for press review in the Johnson Space Center newsroom and will be available in the Headquarters newsroom within 3 days.

NASA News

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For Release:
October 5, 1989

RELEASE: 89-158

NASA SPACECRAFT TO LOOK OUT INTO SPACE, BACK IN TIME

NASA will launch a spacecraft on Nov. 9, 1989, to study the origin and dynamics of the universe, including the theory that the universe began about 15 billion years ago with a cataclysmic explosion -- the Big Bang.

The Cosmic Background Explorer (COBE) spacecraft will be boosted into an Earth polar orbit from Vandenberg Air Force Base, Calif., aboard the final NASA-owned, NASA-launched Delta vehicle.

By measuring the diffuse infrared radiation (cosmic background) that bombards Earth from every direction, COBE's instruments will help clarify such matters as the nature of the primeval explosion -- which started the expansion of the universe and made it uniform -- and the processes leading to the formation of galaxies.

From its orbit 559 miles above Earth, COBE will carry out its cosmic search using three sophisticated instruments: the Differential Microwave Radiometer (DMR), Far Infrared Absolute Spectrophotometer (FIRAS) and Diffuse Infrared Background Experiment (DIRBE)

DMR will determine whether the primeval explosion was equally intense in all directions. Patchy brightness in the cosmic microwave background would unmask the as-yet-unknown "seeds" that led to the formation of such large bodies as galaxies, clusters of galaxies, and clusters of clusters of galaxies. Measurements of equal brightness in all directions would mean the puzzle of how these systems could have condensed since the Big Bang will be even more vexing than it is today.

- more -

To distinguish the emissions of our own Milky Way galaxy from the true cosmic background radiation, DMR will measure radiation from space at wavelengths of 3.3, 5.7 and 9.6 millimeters.

FIRAS, covering wavelengths from 0.1 to 10 millimeters, will survey the sky twice during the year-long mission to determine the spectrum (brightness versus wavelength) of the cosmic background radiation from the Big Bang.

The spectrum that would result from a simple Big Bang can be calculated with great accuracy. Such a spectrum would be smooth and uniform and have no significant releases of energy between the time of the Big Bang and the formation of galaxies. If FIRAS' measurements depart from the predicted spectrum, scientists will know that powerful energy sources existed in the early universe between these times.

These sources may include annihilation of antimatter, matter falling into "black holes," decay of new kinds of elementary particles, explosion of supermassive objects and the turbulent motions that may have caused the formation of galaxies.

FIRAS' sensitivity will be 100 times greater than that achieved so far by equivalent ground-based and balloon-borne instruments. Producing a spectrum for each of 1,000 parts of the sky, the FIRAS data will allow scientists to measure how much light was radiated by the Big Bang.

DIRBE will search for the diffuse glow of the universe beyond our galaxy in the wavelength range from 1 to 300 micrometers. In the final analysis, any uniform infrared radiation that remains will be very rich in information about the early universe. One possible source would be light from primordial galaxies shifted into the far infrared by the expansion of the universe.

The 5,000-pound spacecraft and its three infrared- and microwave-measuring instruments were designed and built for the Office of Space Science and Applications by NASA's Goddard Space Flight Center, Greenbelt, Md. Goddard also will manage the launch and analyze the data returned by COBE during its 1-year nominal mission.

Looking out into space, back in time, the COBE spacecraft will undertake the esoteric task of providing new insights into the origin and evolution of the universe.

- end -

NASA News

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For Release:
October 5, 1989
embargoed until 4 p.m. EDT

RELEASE: 89-159

NASA TO FURTHER DEVELOP 2 EXPLORER SCIENTIFIC SPACECRAFT

NASA has authorized further development for two unmanned scientific spacecraft that would explore interplanetary space and study extragalactic light sources, such as quasars. These studies were submitted to NASA under the Explorer Concept program, designed to develop intermediate-size scientific experiments.

The two programs are: the Lyman Far Ultraviolet Spectroscopic Explorer (FUSE) and the Advanced Composition Explorer (ACE).

FUSE will use high resolution spectroscopy at wavelengths below 1200 angstrom to measure faint sources both throughout the Milky Way galaxy and at very large extragalactic distances. The science team leader for FUSE is Dr. H. Warren Moos, Johns Hopkins University, Baltimore, Md.

ACE will explore the energetic particle populations observed in near-Earth interplanetary space. Measurements of these particles will allow a direct study of interstellar matter. The science team leader for ACE is Dr. E. C. Stone, California Institute of Technology, Pasadena.

The cost for this phase of development, which includes definition studies and preliminary designs, is approximately $3 million for each spacecraft.

The Astrophysics Division of NASA's Office of Space Science and Applications, Washington, D.C., will provide overall program management. Goddard Space Flight Center, Greenbelt, Md., will be the project management center.

- end -

NASA News

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For Release:

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October 11, 1989

STS-34 LAUNCH ADVISORY

NASA officials today evaluated the work that will remain after changing out the number 2 main engine controller to prepare the Atlantis for its next flight. They have estimated there is a fifty-fifty chance of completing the necessary work in time to launch on Tuesday, Oct. 17.

Shuttle engineers and technicians will work towards an objective of launch on Tuesday, but managers will make a final decision at about noon on Saturday, Oct. 14, as to whether a Tuesday launch is achievable or whether the launch will occur on Wednesday, Oct. 18.

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For Release:

October 12, 1989

RELEASE: 89-160 (Update from release 89-152).

NASA CONFIRMS '89 OZONE HOLE MATCHES '87 RECORD

Continuing observations by the Total Ozone Mapping Spectrometer (TOMS) have confirmed that the ozone hole over the Antarctic this year has equalled the record-setting hole observed in 1987, NASA scientists said.

Dr. Arlin Krueger, Dr. Richard Stolarski and Dr. Mark Schoeberl, scientists at the Goddard Space Flight Center in Greenbelt, Md., have been closely monitoring ozone levels over the Southern Hemisphere with the TOMS, an instrument on board NASA's NIMBUS-7 satellite.

Previous measurements had indicated this year's hole might be as severe as the 1987 hole, and a record low ozone level was reached on Oct. 5. Krueger, the TOMS prinicipal investigator, said, "It's becoming clear that the ozone hole is not going away in the near future, although the depth will vary from year to year." The depth of the ozone hole each year will be determined by meteorological conditions, such as temperature and winds.

Through the first week of October, the ozone hole was nearly identical to the hole recorded 2 years ago. By Oct. 5, the minimum value within the ozone hole had decreased by approximately 45 percent from early August, a drop of approximately 1.5 percent per day. In contrast, ozone decreased by only 15 percent in September last year, when the ozone hole was relatively weak.

- more -

Schoeberl reported that in August and September the polar vortex was extremely cold and undisturbed. According to current theory of the ozone hole, these are the ideal conditions for the formation of the polar stratospheric clouds that lead to ozone depletion.

The NIMBUS-7 TOMS instrument has been measuring stratospheric ozone for more than 10 years as part of the Earth Science program managed by NASA's Office of Space Science and Applications. To support Antarctic scientists, Goddard has been processing the data from TOMS in near real-time and observations are transmitted to researchers around the world.

- end -

NOTE TO EDITORS: Color photographs of the ozone hole are available by calling the Goddard Public Affairs Office at 301/286-8957.

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For Release:
October 12, 1989

RELEASE: 89-161

PRIVATE MEDICAL CONSULTATIONS TO BECOME SPACE FLIGHT ROUTINE

Medical consultations between astronauts in space and NASA physicians on Earth will become a routine part of future Space Shuttle flights to help improve the understanding and provide timely treatment of initial space motion sickness symptoms.

A private medical communication will be scheduled between Shuttle crew members and Mission Control Center flight surgeons during the pre-sleep periods on the first 2 days of each flight beginning with STS-34 this month. Additional consultations may be requested by either the crew or the flight surgeons.

"The communication will assure the most effective treatment of space motion sickness symptoms during the first 2 days of flight when the condition is most prevalent," said Dr. Jeff Davis, chief of Johnson Space Center's Medical Operations Branch.

"While symptoms vary from one person to another," Davis said, "most cases are mild and constitute little more than an inconvenience to the crew member. Given the variation in symptoms and available treatments, we felt it would be useful to plan routine consultations for the first 2 days of each mission."

The consultations will be confidential because of the physician-patient relationship and privacy laws. If a crew health problem is determined to affect a mission adversely, the flight surgeon will prepare a statement for public release which will address the nature, gravity and prognosis of the situation. Information beyond that required to understand mission impact will not be released.

\- end -

NASA News

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For Release:
October 19, 1989

RELEASE: 89-163

NASA'S ER-2 AIRCRAFT TAKING EARTHQUAKE DAMAGE ASSESSMENT PHOTOS

NASA's ER-2 high-altitude research aircraft is taking aerial photographs of areas affected by the October 17th San Francisco-area earthquake. In general support of President Bush's request that federal agencies support earthquake recovery activity, the ER-2 is taking photos of the damage area from Santa Cruz to Marin County.

Operated by NASA's Ames Research Center, Mountain View, Calif., one of the areas affected by Tuesday's earthquake, the ER-2 flies at an altitude of 65,000 feet and can provide broad area coverage and high-resolution photography. Camera equipment on board would be able to see large-scale natural damage such as landslides or unusual water flow. It also may be able to detect changes in linear features such as fault lines.

Copies of selected earthquake damage assessment photographs will be made available to local, state and federal authorities.

-end-

NASA News

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For Release:

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October 20, 1989

RELEASE: 89-164

NASA AND NOAA SEND VLBI TO STUDY CALIFORNIA EARTHQUAKE MOVEMENT

NASA and the National Oceanic and Atmospheric Administration (NOAA) have deployed mobile Very Long Baseline Interferometry (VLBI) systems to the San Francisco Bay area to measure the crustal motion associated with Tuesday's earthquake.

The mobile VLBI units will measure, to an accuracy of approximately 1 centimeter, the positions of survey monuments at the Presidio, Fort Ord and Point Reyes, Calif., relative to points sufficiently distant from the earthquake to be unaffected by it. The survey monuments were installed under a multi-agency program specifically to monitor crustal motion in California. Measurements since 1983 have shown steady motion of a few centimeters per year as the Pacific Plate moves past the North American Plate. The measurements to be collected in the next few days and weeks should detect any change in this pattern caused by the earthquake. The much stronger earthquake of 1906 produced surface motions of several meters in this same region.

The mobile VLBI units were developed by NASA and are operated for the Crustal Dynamics Project of NASA's Office of Space Science and Applications and NOAA's Climate and Global Change Program by the National Geodetic Survey Division of NOAA. They are maintained at the Mojave Base Station, near Barstow, Calif.

The mobile units consist of small aperture (about 13 feet in diameter) radio telescopes, Hydrogen Maser atomic clocks, highly sensitive microwave receivers, tape recorders and other electronic instruments to record the faint signals emitted by extragalactic radio sources (quasars) billions of light years from Earth. The same signals will be recorded simultaneously at larger fixed radio telescopes in California, Alaska and Massachusetts.

- more -

The tapes containing the signals are processed at special correlator facilities in Massachusetts and Washington, D.C., and the distances and directions between all of the stations will be computed. Preliminary results will be available within several days of the observations.

The first mobile unit (MV-2) left the Mojave Base Station on Wednesday for the Presidio station and will make its first observations Friday. A second unit (MV-3) had just completed a three-month observation campaign in Europe and the eastern United States and was returning to Mojave when the earthquake occurred. It was diverted to the earthquake area and is expected to arrive at the Fort Ord station Saturday.

The two units will make a number of measurements at the Presidio, Fort Ord and Point Reyes stations and Quincy, Calif., during the next few weeks. The findings from the mobile VLBI units will provide reference points from which other geodetic surveying techniques, including satellite observations using the Global Positioning System (GPS), can be used to map the crustal deformation associated with the earthquake in greater detail.

NASA and NOAA are also participating with the National Science Foundation and California Institute of Technology in a simultaneous GPS measurement campaign coordinated by the U.S. Geological Survey (USGS) in response to the recent earthquake.

More information on the technical and scientific aspects of this work can be obtained by contacting Dr. Herbert Frey, NASA Headquarters, Washington, D.C. (202/453-8953) or Dr. William E. Carter, National Geodetic Survey, Rockville, Md. (301/443-8423). Further information about the field operations, including arrangements for news media visits to the mobile units, should be requested from Mr. Charles C. Mitchell, Mojave Base Station, Barstow, Calif. (619/386-8349).

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202-453-8400

For Release:

Jeff Vincent
Headquarters, Washington, D.C.
(Phone: 202/453-8400)

1:00 p.m. EDT
October 26, 1989

RELEASE: 89-165

TRULY UPDATES AERONAUTICS AND SPACE PROGRAMS FOR PRESS CLUB

Four months after becoming NASA Administrator, Vice Admiral Richard H. Truly issued an upbeat assessment of the agency's many programs and said an analysis of future manned missions to the moon and Mars "is proceeding exceedingly well."

While the Moon and Mars missions "will be technically demanding and not without risk, they are well within our reach," Admiral Truly said at a National Press Club luncheon in Washington, D.C.

"These expeditions will stimulate new technologies and enhance our nation's long-term productivity," Admiral Truly said. "They will improve national competitiveness. They will advance scientific knowledge and lead to discoveries about our solar system, Earth and life, itself."

The NASA leader's broad-brush review of current NASA programs included the following highlights:

* Aeronautics - NASA technology has enabled the U.S. aerospace industry to maintain "an unqualified lead in world markets." To help maintain this position, NASA has revived research on a high-speed civil transport -- research that will lead to "environmentally sound, supersonic travel for the future."

* Space Science - The recent launches of the Galileo and Magellan space probes ushers in an extraordinary era of space science missions. Over the next 5 years, NASA will launch 37 space missions that will "radically change our understanding, not only of the universe but also of ourselves."

- more -

* "Mission to Planet Earth" - Using "superior new instruments," we can take a comprehensive look at the entire global system -- lands, oceans, ice and atmosphere. This program is taking shape and promises to provide data that "will be coordinated in a decades-long effort to better understand our fragile Earth."

* Space Shuttle - With six successful missions since the return to flight, NASA is moving confidently to safely increase the Shuttle's flight rate. The Shuttle is "unquestionably a far safer and much more reliable vehicle" and will be critical in the construction of Space Station Freedom.

* Space Station Freedom - The "cornerstone of our future in space," Freedom is the largest international cooperative space project ever undertaken. It is an essential step toward moving again beyond Earth orbit and into the solar system, providing new insights into the human body and psyche as we cope with longer durations of space flight; allowing us to test exploration technologies; and permitting the assembly service of space vehicles.

Last July 20, the 20th anniversary of the Apollo 11 moon landing, President Bush committed the United States to return to the moon and then explore Mars. NASA is supporting the efforts of the National Space Council, chaired by Vice President Quayle, to determine what resources will be required and to set a realistic timetable to meet these goals.

Admiral Truly said the benefits of future missions to the moon and Mars are difficult to quantify and include such intangibles as knowledge, success and pride. "Each time we go to the frontier and beyond," he said, "we bring back more than we hoped for. This time we have the chance to bring back more than we can imagine."

He also said manned space exploration will stimulate science and engineering education in the United States. "I feel strongly that NASA has a special responsibility in education for a very special reason. Our programs -- airplanes, spaceships, moon, Mars and astronauts -- can get to kids."

- end -

Note: Copies of Admiral Truly's prepared remarks are available from the NASA Newsroom, Room 6043, 400 Maryland Ave., S.W., Washington, DC 20546 (phone: 202/453-8400).

NASA News

National Aeronautics and
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Jeff Vincent
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For Release:
October 27, 1989

RELEASE: 89-166

ADMINISTRATOR TRULY GIVES BOOST TO READING PROGRAM

NASA Administrator Richard H. Truly took his launch skills to an elementary school today and personally helped a new reading program get off the ground. It was a successful mission.

Meeting with about 340 students at the Rock Creek Forest Elementary School, Montgomery County, Md., Admiral Truly helped initiate the "Launch into a Good Book" program, which is designed to encourage reading among elementary school children. The program features audio cassettes with prominent people reading book passages. The students can read along and practice their skills.

Admiral Truly presented the students with an audio tape on which he read a passage from "Album of Spaceflight" by Tom McGowen. He also spoke briefly with them about the importance of reading and how it is an essential skill for achieving their goals, including those who aspire to space travel.

Just yesterday, at a speech to the National Press Club, Admiral Truly said: "There is a new determination across our land to improve our educational system." He said there are certain themes that are particularly effective in reaching children. "Ghosts can do it, dinosaurs can do it, and space can do it. I predict that no other benefit from our future space endeavors will loom so large."

The NASA Administrator also participated in the President's recent education summit with the nation's governors in Charlottesville, Va.

- end -

NASA News

National Aeronautics and
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Washington, D.C. 20546
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Dwayne C. Brown
Headquarters, Washington, D.C.
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November 1, 1989

For Release:

RELEASE: 89-168

NASA PRESENTS EXCELLENCE AWARD TO LOCKHEED

The Lockheed Engineering and Sciences Co. (LESC), Houston, has been named recipient of the 1988-89 NASA Excellence Award for Quality and Productivity.

NASA Deputy Administrator J.R. Thompson announced the selection last night at the Sixth Annual NASA/Contractors Conference, Huntsville, Ala. He said that, for well over 23 years, LESC has applied the highest level of talent, proficiency and consistency in supporting all the major manned space flight programs.

LESC was structured to provide high-technology engineering, science, management and technical support for government programs. The award reads that LESC has continually improved operations, primarily as a support contractor for NASA's Johnson Space Center, Houston, and that the company has a long track record of sustained excellent performance, coupled with continuing innovative programs -- setting the standard for the service industry as a leader in quality and productivity.

LESC was selected by the NASA Quality and Productivity Steering Committee and endorsed by the Administrator based on review of the findings report and recommendations of the Excellence Award Evaluation Committee.

The seven other finalists for the 1988-89 award were:

o Barrios Technology, Inc., Houston
o Bendix Field Engineering Corp., Columbia, Md.
o Boeing Computer Support Services (CMS), Huntsville, Ala.
o Computer Sciences Corp., Houston
o EG&G Florida, Inc., Kennedy Space Center, Fla.
o Grumman Technical Services Div., Titusville, Fla.
o Rockwell International, Space Transportation Div., Downey, Calif.

-more-

"Each of these firms has demonstrated admirable performance in attaining a level of quality and productivity that commands our respect and deep appreciation," said George Rodney, NASA Associate Administrator for Safety, Reliability, Maintainability and Quality Assurance.

Award criteria, developed by NASA in conjunction with the American Society for Quality Control, Milwaukee, Wisc., were used to judge nominees on performance achievements and improvements in customer satisfaction, quality and productivity levels. Emphasis also was placed on management commitment, goals and measures, communication, health and safety, work force training, award recognition and subcontractor involvement.

Key goals of the NASA Excellence Award are to institutionalize quality and productivity practices, not only throughout NASA and the agency's contractors, but also the rest of the industrial world.

To encourage more small businesses to improve their quality and productivity processes, NASA is establishing a separate small business category for the 1989-90 Excellence Award Program.

Initial nomination letters for large and small businesses are due by Dec. 1, 1989, with the final application reports due March 1, 1990.

Information on the 1989-90 award program can be obtained by contacting NASA Headquarters, Mail Code QB, 600 Independence Ave., S.W., Washington, D.C. 20546 (phone: 202/453-8415), or by writing to the American Society for Quality Control, 310 West Wisconsin Avenue, Milwaukee, Wisc. 53203.

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NASA News

National Aeronautics and
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For Release:

November 1, 1989

RELEASE: 89-169

NASA APPOINTS SPACELAB PAYLOAD SPECIALISTS

Dr. Lennard A. Fisk, NASA's Associate Administrator for Space Science and Applications, recently appointed two Spacelab payload specialists. Dr. Millie Hughes-Fulford will be a prime payload specialist for Spacelab Life Sciences-1 (SLS-1) and Dr. Stanley N. Koszelak will serve as the U.S. backup payload specialist for Spacelab-J.

Hughes-Fulford, 43, previously assigned to Spacelab Life Sciences-2 as the prime payload specialist, has been reassigned to SLS-1 to replace Dr. Robert W. Phillips, 60. Phillips is stepping down because he did not meet the medical standards for a payload specialist. He will continue his duties as an SLS-1 mission support team member.

Hughes-Fulford is an associate professor of biochemistry at the University of California Medical Center, San Francisco, and a medical researcher at the Veterans Administration Medical Center in San Francisco.

SLS-1 is the first mission to use Spacelab, a laboratory that fits in the Space Shuttle cargo bay, as a biological research facility. The 20 scientific investigations onboard will help answer critical questions about the way humans adapt to microgravity and readapt to Earth's gravity.

Koszelak, 36, is an assistant research biochemist at the University of California at Riverside. As the U.S. backup payload specialist for Spacelab-J, Koszelak will perform critical ground support duties during the mission. Spacelab-J is jointly sponsored by NASA and the National Space Development Agency of Japan. A Japanese payload specialist also will fly on Spacelab-J.

SLS-1 is scheduled to fly in August 1990 aboard Space Shuttle orbiter Columbia and is managed by the Johnson Space Center, Houston, for NASA's Office of Space Science and Applications (OSSA), Washington, D.C. Spacelab-J, scheduled to fly in June 1991, is managed by the Marshall Space Flight Center, Huntsville, Ala., for NASA's OSSA.

- end -

National Aeronautics and
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For Release:
Nov. 7, 1989

RELEASE: No. 89-170

MOBILE VLBI UNITS MEASURE MOVEMENT FROM LOMA PRIETA EARTHQUAKE

Preliminary measurements near Fort Ord, Calif., taken by mobile Very Long Baseline Interferometry (VLBI) systems, show abrupt crustal movement of approximately 2 inches caused by the Loma Prieta earthquake, said VLBI Systems Manager Dr. Tom Clark of the Goddard Space Flight Center, Greenbelt, Md. This figure is close to the 3.2 inches predicted by scientists based on early models of the rupture.

The measurements, taken immediately after the quake, are a special set in the series of geologic measurements taken by the Goddard Space Flight Center's Crustal Dynamics Project (CDP) and the National Oceanic and Atmospheric Administration's National Geodetic Survey (NGS). The agencies have been monitoring sites along California's San Andreas fault since 1972.

The VLBI technique is derived from radio astronomy. Several radio telescopes make simultaneous observations of weak radio signals from quasars billions of light-years from Earth. Sophisticated electronics allow the timing of these signals to about 30 picoseconds -- the length of time it takes radio waves to travel 1 centimenter.

A number of these precise measurements are taken over one day at several stations and are combined to produce measurements, accurate to approximately 0.4 inches, of the site positions.

In addition to large fixed radio telescopes around the world, the CDP and NGS operate two mobile VLBI systems, each consisting of two trailers and a dish antenna. The CDP and NGS deployed these two systems to Bay Area sites immediately after the earthquake.

- more -

By Oct. 20, the system called MV-2 was on the air at the Presidio, near San Francisco's Golden Gate Bridge. Over the past several years, VLBI measurements have shown the Presidio to be moving northwestward at 1.28 inches per year with respect to the interior of the United States, according to Clark. Preliminary analysis of the crustal motion measurements taken indicate no movement greater than 0.8 inches as a result of the Oct. 17 earthquake, consistent with predictions based on models of the rupture.

The second mobile VLBI system, MV-3, was operating by Oct. 22 at Fort Ord, about 31 miles south of the earthquake's epicenter. Previous VLBI measurements had shown Fort Ord to be moving with nearly the full rate of the Pacific plate (northwestward at 1.84 inches per year).

Initial analysis of the Fort Ord data, taken after the earthquake, shows that this area moved 2 inches nearly due north. The movement was detected by the change of the baseline between Fort Ord and the University of California's Hat Creek Radio Observatory, 289 miles north of Fort Ord. However, no length changes were seen to the NGS/CDP Mojave Base Station at Goldstone, 288 miles east-southeast of Fort Ord. To date, only a part of the data has been analyzed. When completed, the data will yield a two-dimensional uncertainty of about 0.4 inches for each of the measurements.

The MV-3 system will continue to operate at Fort Ord to monitor further earthquake-related motion through Nov. 16. The MV-2 system will make observations at several other northern California sites, returning to the Presidio on Nov. 11.

The mobile VLBI units were developed by NASA and are operated for the Office of Space Science and Applications through Goddard's Crustal Dynamics Project and NOAA's Climate and Global Change Program by the National Geodetic Survey Division of NOAA. Preliminary data processing was done at the Haystack Observatory in Massachusetts and analyzed at the Goddard Space Flight Center.

- end -

NASA News
National Aeronautics and
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November 8, 1989

RELEASE: 89-171

DETAILED CONSOLIDATION OF SPACE FLIGHT/SPACE STATION OFFICES ANNOUNCED

NASA Administrator Richard H. Truly today provided additional details on the consolidation of the Offices of Space Flight and Space Station into a single organization headed by Associate Administrator Dr. William B. Lenoir. The newly formed organization will be called the Office of Space Flight (OSF). George Abbey will continue to serve as the Deputy Associate Administrator for the organization.

"The consolidation provides a structure within which the leadership and accomplishment of assigned programs and space transportation will be assured," said Lenoir. "The division of responsibilities is clear and the mechanisms to assure coordination are in place."

It is planned that the Space Flight organization will include four major areas: Space Shuttle, Space Station Freedom, Space Flight Systems and Human Resources and Institutions. Robert L. Crippen is the acting Director of the Space Shuttle Program, and Richard H. Kohrs is the Director of the Space Station Freedom Program. Joseph B. Mahon is the Director for Flight Systems, and Richard J. Wisniewski is the Director for Human Resources and Institutions.

Several offices and staff positions will provide Lenoir with direct support. Those areas are Resources Management with responsibility for resource evaluation and integration for all OSF programs, and Program Control for Space Station Freedom in Reston and the Space Shuttle at JSC; Transportation Services which will serve as the interface with space transportation customers; an Executive Unit with responsibility for correspondence control, audit functions, reviews of NASA Management Instructions, and administrative and management services to the OSF organization at NASA Headquarters; and a Technical Integration and Analysis Office which will provide the Associate Administrator with a quick-response capability in dealing with selected technical issues or concerns.

-more-

The consolidation results in no major changes in the Space Shuttle program. At NASA Headquarters, the organization now in place continues with the major functions of Program Plans, System Engineering and Analysis, and Operations Utilization. Two deputies, one for program and one for operations continue to be located at the Johnson Space Center, Houston, and Kennedy Space Center, Fla., respectively. Lines of communication and decision making remain unchanged.

The most significant changes made as a result of the consolidation have been made to program management organizational elements within the Space Station Freedom Program. This organization has been strengthened and program management has been consolidated into NASA Headquarters, Washington, D.C., and Reston, Va.

The Program Director's office will now include three major functions: engineering, operations and policy. The Deputy Director, Robert Moorehead, is located in Reston, Va. The Deputy Director is supported by a Deputy for Operations, also located at Reston, and a Deputy for Integration, located at JSC. The Deputy for Integration is supported by two field offices, with a manager for element integration at the Marshall Space Flight Center, Huntsville, Ala., and a manager for system integration at JSC. At Reston, strong staff offices in system engineering and analysis, management integration, and safety, reliability and quality assurance are retained.

No major organizational changes have been made within the Space Flight Systems division.

A new focus on human resources management has been assigned to the Human Resources and Institutions organization. Primary responsibilities continue to be the advocacy, determination and recommendation of manpower, facilities and other institutional resources. The focus on leadership development within the Office of Space Flight at NASA Headquarters and across the centers will be strengthened.

-end-

NASA

COSMIC BACKGROUND EXPLORER (COBE)

PRESS KIT

Release: 89-172

NOVEMBER 1989

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CONTENTS

GENERAL PRESS RELEASE

NASA SPACECRAFT TO LOOK OUT INTO SPACE, BACK IN TIME

NASA will launch a spacecraft on Nov. 17, 1989, to study the origin and dynamics of the universe, including the theory that the universe began about 15 billion years ago with a cataclysmic explosion -- the Big Bang.

The Cosmic Background Explorer (COBE) spacecraft will be boosted into an Earth polar orbit from Vandenberg Air Force Base, Calif., aboard the final NASA-owned, NASA-launched Delta vehicle.

By measuring the diffuse infrared radiation (cosmic background) that bombards Earth from every direction, COBE's instruments will help clarify such matters as the nature of the primeval explosion -- which started the expansion of the universe and made it uniform -- and the processes leading to the formation of galaxies.

From its orbit 559 miles above Earth, COBE will carry out its cosmic search using three sophisticated instruments: the Differential Microwave Radiometer (DMR), Far Infrared Absolute Spectrophotometer (FIRAS) and Diffuse Infrared Background Experiment (DIRBE).

DMR will determine whether the primeval explosion was equally intense in all directions. Patchy brightness in the cosmic microwave background would unmask the as-yet-unknown "seeds" that led to the formation of such large bodies as galaxies, clusters of galaxies, and clusters of clusters of galaxies. Measurements of equal brightness in all directions would mean the puzzle of how these systems could have condensed since the Big Bang will be even more vexing than it is today.

To distinguish the emissions of our own Milky Way galaxy from the true cosmic background radiation, DMR will measure radiation from space at wavelengths of 3.3, 5.7 and 9.6 millimeters.

FIRAS, covering wavelengths from 0.1 to 10 millimeters, will survey the sky twice during the year-long mission to determine the spectrum (brightness versus wavelength) of the cosmic background radiation from the Big Bang.

- more -

The spectrum that would result from a simple Big Bang can be calculated with great accuracy. Such a spectrum would be smooth and uniform and have no significant releases of energy between the time of the Big Bang and the formation of galaxies. If FIRAS' measurements depart from the predicted spectrum, scientists will know that powerful energy sources existed in the early universe between these times.

These sources may include annihilation of antimatter, matter falling into "black holes," decay of new kinds of elementary particles, explosion of supermassive objects and the turbulent motions that may have caused the formation of galaxies.

FIRAS' sensitivity will be 100 times greater than that achieved so far by equivalent ground-based and balloon-borne instruments. Producing a spectrum for each of 1,000 parts of the sky, the FIRAS data will allow scientists to measure how much light was radiated by the Big Bang.

DIRBE will search for the diffuse glow of the universe beyond our galaxy in the wavelength range from 1 to 300 micrometers. In the final analysis, any uniform infrared radiation that remains will be very rich in information about the early universe. One possible source would be light from primordial galaxies shifted into the far infrared by the expansion of the universe.

The 5,000-pound spacecraft and its three infrared- and microwave-measuring instruments were designed and built for the Office of Space Science and Applications by NASA's Goddard Space Flight Center, Greenbelt, Md. Goddard also will manage the launch and analyze the data returned by COBE during its 1-year nominal mission.

Looking out into space, back in time, the COBE spacecraft will undertake the esoteric task of providing new insights into the origin and evolution of the universe.

- end -

COSMIC BACKGROUND EXPLORER SUMMARY

MISSION: During the 2-year mission, COBE will determine the spectrum of the cosmic background radiation, search for radiation from the very first stars and galaxies and map the cosmic background radiation with unprecedented accuracy. COBE will study the physical conditions in the very early universe and the onset of organization following the Big Bang.

LAUNCH: No earlier than 11/16/89, aboard a Delta 5920 ELV, from Space Launch Complex 2 - West, Western Space and Missile Center, Vandenberg Air Force Base, Calif. Launch window is 1/2 hour beginning at 6:24 a.m. PST. An Advanced Range Instrumentation Aircraft will cover the down-range burn of the Delta rocket.

ORBIT: 559-mile, sun-synchronous, near polar orbit, will circle the globe 14 times a day.

SCIENCE DATA: Once a day, data are transmitted to Goddard Space Flight Center's Wallops Processing Flight Facility then forwarded to the COBE Science Data Center at GSFC.

SPACECRAFT: With 3 solar arrays deployed, 16 feet long, 28 feet in diameter, weighing 5,000 lbs.

INSTRUMENTS: Differential Microwave Radiometer, Diffuse Infrared Background Experiment and the Far Infrared Absolute Spectrophotometer.

NOTE: a) Explorers are relatively small, free-flying scientific spacecraft. b) COBE is the 65th Explorer mission. c) COBE has the most sensitive detectors ever flown in a space mission. d) COBE will use the 184th and last NASA-owned Delta.

THE COSMIC BACKGROUND EXPLORER MISSION

NASA's COBE mission will produce the most comprehensive observations to date of the early universe.

The wavelength band to be studied by COBE includes the cosmic background radiation or so-called "remnant radiation," believed to be the signature of the primeval cosmic explosion, the "Big Bang." Current theory also holds that this band contains radiation characteristic of the formation of the first galaxies and stars. It also might provide evidence of other exotic and energetic events occurring in the epochs between the Big Bang and the formation of galaxies.

COBE will carry three sophisticated, state-of-the-art instruments to study the background radiation: the Differential Microwave Radiometer (DMR), the Far Infrared Absolute Spectrophotometer (FIRAS) and the Diffuse Infrared Background Experiment (DIRBE).

Because the diffuse cosmic background radiation itself is extremely faint, the COBE spacecraft and its three experiments have been designed to allow observations at unprecedented sensitivities. To that end, the spacecraft will carry the instruments high above the Earth's atmosphere, protect them from the light and heat of the sun and the Earth, supply them with electrical power and commands and transmit the data they accumulate to the ground.

Two of the three science instruments aboard the spacecraft, FIRAS and DIRBE, reside in a Dewar -- a giant "thermos bottle" -- filled with liquid helium to provide a stable, low-temperature environment within 2 degrees Celsius of absolute zero.

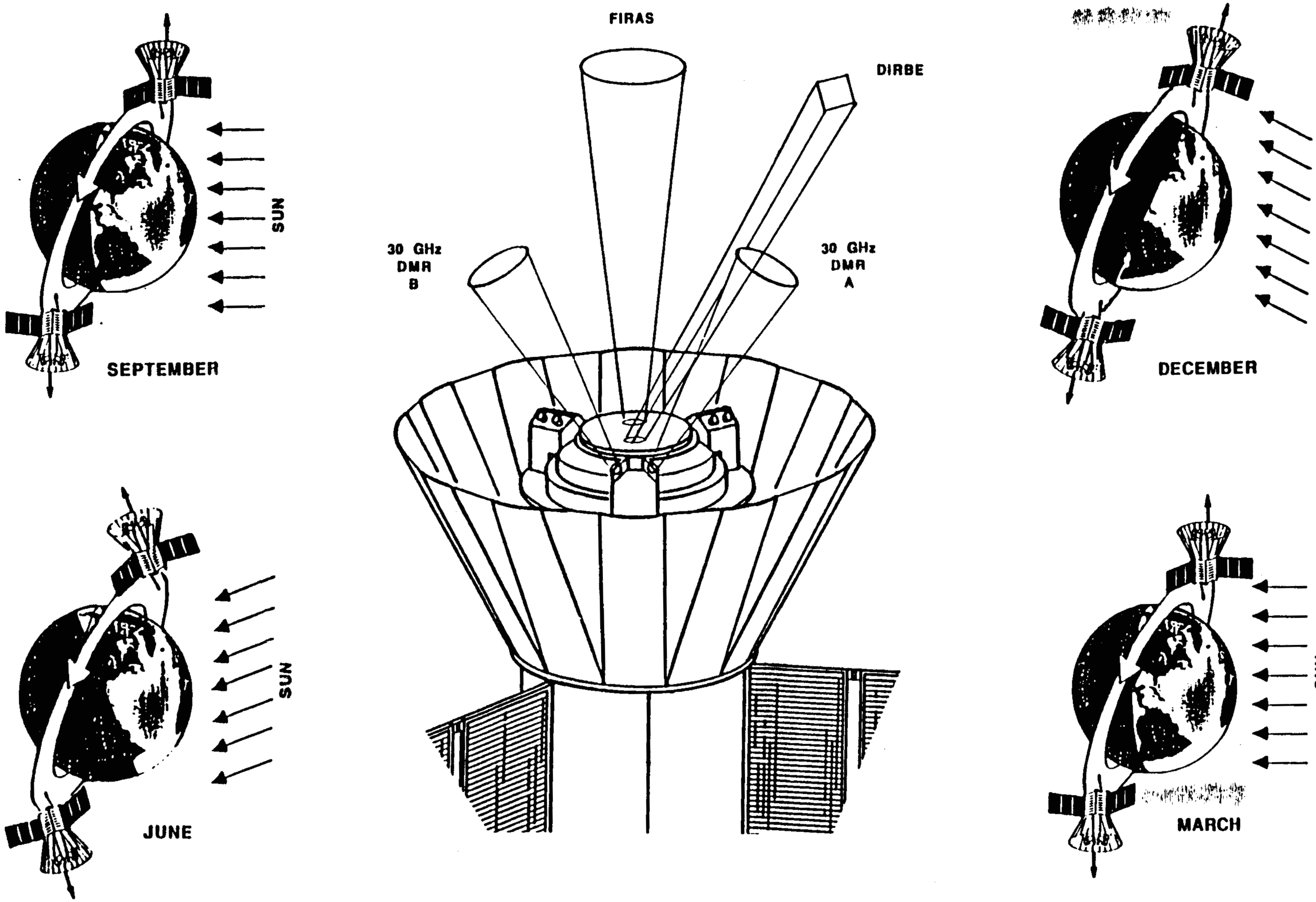
The COBE spacecraft weighs 5,000 pounds, is 16 feet long and is 28 feet in diameter with its three solar panels deployed. The upper half of the observatory is the instrument module, consisting of the three instruments, the liquid helium Dewar and a shield that is deployed when COBE reaches its orbit to protect the instruments from radiation from the sun and the Earth.

Directly under the instrument module is the spacecraft module which includes the mechanical support structure, the attitude control system and the spacecraft and instrument electronics. To allow its instruments to scan the sky, COBE will spin on its axis at a rate of 0.8 rpm.

COBE's attitude control system will keep the spin axis pointed almost directly away from the Earth and 94 degrees away from the sun. The sophisticated attitude control system is comprised of sun and Earth sensors, reaction wheels to provide control torque from the Earth's magnetic field, a pair of large rotating momentum wheels, electromagnets to transfer excess angular momentum from the spacecraft to the Earth's magnetic field and a complex set of control electronics.

Monitoring of the status of the spacecraft and operational commands from the ground will go through the Tracking and Data Relay Satellite System (TDRSS). The science data from the instruments will be recorded on two onboard tape recorders and played back to a ground receiving station at Wallops Island, Va., once a day. These data then will be forwarded to the science team at the COBE Science Data Center, Goddard Space Flight Center, Greenbelt, Md.

COBE will be launched by a two-stage Delta 5920 launch vehicle from Space Launch Complex 2 West at the Western Space and Missile Center, Vandenberg Air Force Base, Calif.



COBE Instrument Fields of View and Solar Alignments

COBE will be placed into a circular, near polar orbit 559 miles above the surface of the Earth. Because the plane of the orbit will be inclined 99 degrees to the Equator, the orbital plane will precess (turn) approximately 1 degree per day, thus maintaining a constant orientation of the spacecraft and its orbit with respect to the sun.

COBE's nominal mission lifetime is 1 year, allowing its instruments to scan the entire sky at least twice. The actual operational lifetime of the FIRAS and DIRBE instruments may be somewhat longer and will be determined by the rate at which the liquid helium boils away as heat flows into the dewar. It is anticipated that the spacecraft will be operated for a second year to allow the DMR to repeat its scans of the sky and achieve even greater sensitivity.

The Delta 5920 is approximately 116 feet long and a maximum of 8 feet in diameter. The first stage is a modified Thor booster incorporating nine Castor 4A strap-on, solid-fuel rocket motors. The first stage main engine is gimbal-mounted and uses liquid oxygen and kerosene. The second stage has a gimbal-mounted, pressure-fed restartable engine fueled with liquid nitrogen tetroxide and aerozene 50.

Injection into the final mission orbit is accomplished at completion of the second burn of the Delta second stage, approximately 1 hour after lift-off. An 8-foot diameter fairing protects the spacecraft from aerodynamic heating during the boost and is jettisoned as soon as the vehicle leaves the sensible atmosphere (shortly after second stage ignition). The fairing separation initiates signals to the spacecraft to properly configure the dewar vent valves in the observatory cryogenic cooler.

MAJOR MISSION EVENTS

Once the final mission orbit is reached, the Delta reorients to the required separation attitude and the Delta inertial guidance computer sends a signal to the spacecraft signal conditioning unit to start deployment. That sequence begins with the RF/thermal shield deployment prior to spacecraft separation from the second stage.

The COBE spacecraft is attached to the second stage Delta by a 6019 payload attach fitting. Because the spacecraft requires a near-zero tip-off rate at separation, a two-step release system, consisting of three explosive nuts and a secondary latch system will be used. At spacecraft separation, the Delta vehicle second stage will use cold gas to back away from the COBE spacecraft.

The signal conditioning unit then initiates momentum wheel spin-up, solar array deployment, transmitter turn-on and antenna deployment. The dewar cover is deployed by ground command approximately 4 days after separation.

Three solar arrays provide 712 watts of power to the 5,000-lb. spacecraft. During solar eclipses, batteries will be used to support the power loads and will be recharged during the sunlit portion of the orbit.

COBE MISSION PHASES

LAUNCH

Location: Space Launch Complex 2-West (SLC-2W), Western Space and Missile Center, Vandenberg Air Force Base, Calif.

Time/Date: 6:24 a.m. (PST),Thurs., Nov. 17, 1989 with a launch window of 30 minutes.

Launch vehicle: Delta expendable launch vehicle (ELV) model 5920.

EARLY ORBIT

Liftoff (LO) +57 min., 21 sec.: The COBE spacecraft will be placed into its operational orbit of 559 miles by the second stage of the Delta 5920.

LO+60 min., 28 sec.: The Delta ELV sends discrete signals to start COBE's signal conditioning unit (SCU) -- a sophisticated electronic timer -- as the Delta is reoriented to the attitude required for the spacecraft to separate from the Delta.

LO+60 min., 29 sec.: The COBE SCU turns on the telemetry transmitter.

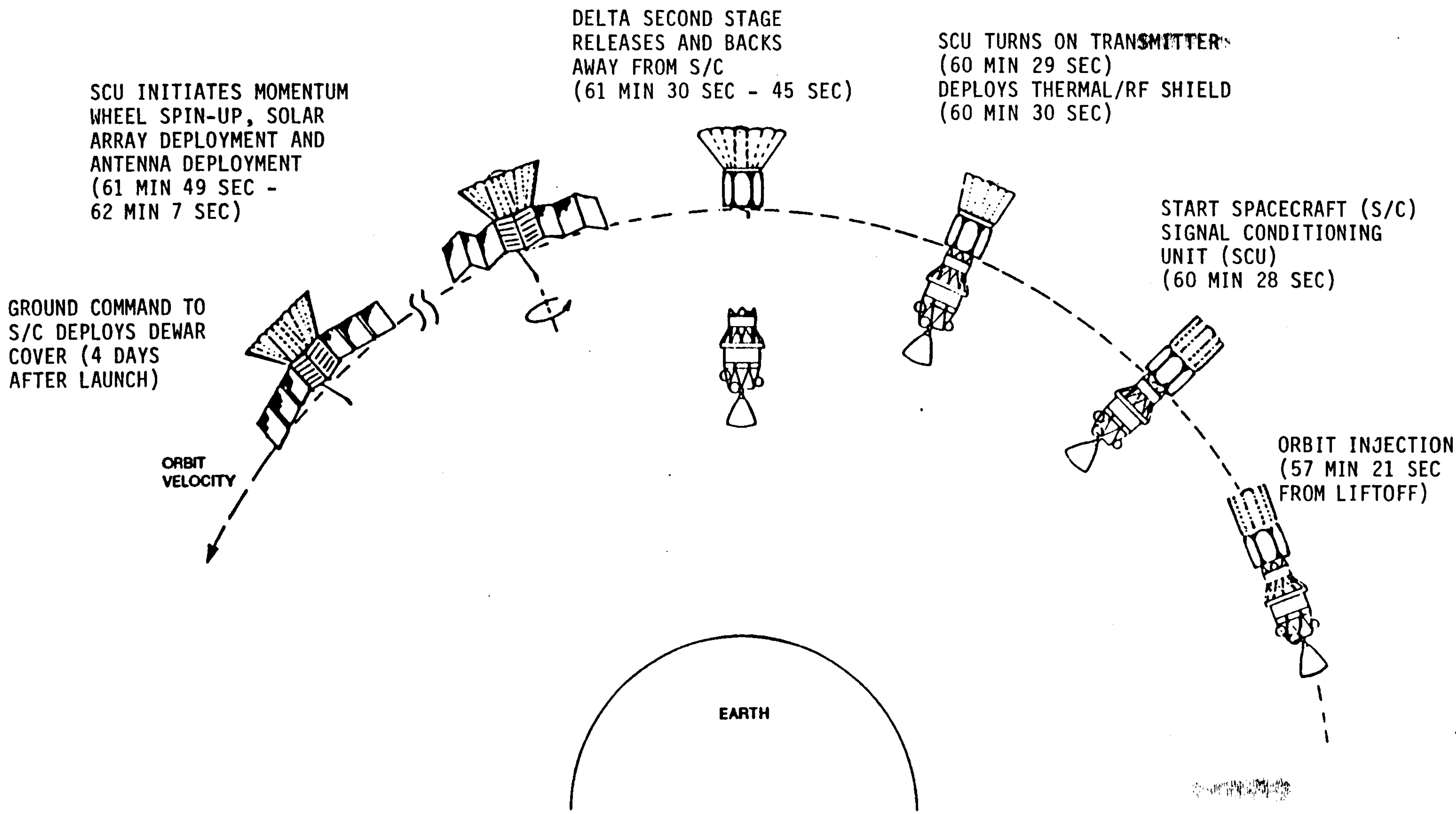
LO+60 min., 30 sec.: The SCU initiates thermal/radio frequency shield deployment.

LO+61 min., 30-45 sec.: The Delta second stage releases and backs away from the COBE.

LO+61 min., 49 sec. to 62 min., 7 sec.: The SCU initiates momentum wheel spin-up, solar array deployment and antenna deployment.

OBSERVATORY/INSTRUMENT CHECK-OUT

There will be a 14-day checkout phase, followed by an additional 16-day instrument characterization and calibration phase. During this phase, transition to normal survey operations will occur. After initial ground contact at separation, communications between COBE and the Earth will be via the Tracking and Data Relay Satellite System (TDRSS). During observatory checkout, TDRSS support on an every orbit basis will be requested, to be gradually reduced over a transition period.



COBE ORBIT INJECTION AND DEPLOYMENTS

Once the observatory and instruments have been fully checked, characterized and calibrated (approximately 30 days after launch), an S-band, single access forward and return link will be required for up to 2 hours per day. The 2-hour total time will be scheduled over a 24-hour period on an every-other-orbit basis (15 orbits per day).

The observatory engineering checkout extends from day 1 through day 3; the instrument engineering checkout goes from day 3 through day 14; and the instrument characterization and calibration phase lasts from day 15 through day 30. In addition, the day-to-day schedule will plan the following.

Day 1: RF acquisition, attitude stabilization and spacecraft subsystem initialization.

Day 2: Differential Microwave Radiometer (DMR) instrument power up and calibration, and spacecraft subsystem checkout (including attitude maneuvers).

Day 3: Far Infrared Absolute Spectrophotometer (FIRAS) and Diffuse Infrared Background Explorer (DIRBE) instrument power up.

Day 4: Attitude maneuver and dewar cover ejection (by ground command from the Payload Operations Control Center at GSFC).

Day 5: FIRAS instrument mechanism unlatching and additional instrument engineering checkout.

Day 6: Spacecraft spin-up to operational spin rate (0.815 rpm).

Day 7: Attitude pitch maneuver checkout.

Day 8: Attitude roll maneuver checkout and additional instrument checkout.

Day 9-11: Instrument checkout aided by attitude roll and pitch maneuvers.

Day 12-14: Instrument checkout and survey mode parameters adjustments.

During the characterization and calibration phase, the instruments collect science data, are calibrated and are further characterized as orbital and astronomical events occur.

By day 30 the instruments have been calibrated, characterized and adjusted to proceed with normal survey operations.

MISSION OPERATIONS

The COBE flight operations team will control the COBE spacecraft from the Payload Operations Control Center, Goddard Space Flight Center, Greenbelt, Md., 24 hours a day, 7 days a week following launch. During this time, the following data events are programmed daily:

o Real-time contact by the flight operations team through TDRSS every other COBE orbit. This contact will allow for up-link of stored commands once a day; monitoring of subsystems for health and safety; collection of tracking data and updating of the COBE clock drift. This will maintain clock accuracy within 10 milliseconds of Universal Time.

o One onboard tape recorder playback transmitted each day to Wallops Flight Facility (WFF), Va., for data relay to the COBE Science Data Room at Goddard Space Flight Center. At the 655.4 kilobits per second data dump rate, 24 hours of recorded data can be transmitted to Wallops in about 9 minutes.

There will be a minimum of three passes within range of the WFF ground station each day. These passes will be a minimum of 10 minutes long and will occur at nearly the same time each day. This regularity will be used to routinely schedule the data acquisitions.

MISSION LIFETIME

COBE is planned to operate for 24 months following launch. The nominal mission lifetime is 12 months. Minimum mission lifetimes to complete an all-sky survey are 6 months for FIRAS and DIRBE and 12 months for DMR. FIRAS and DIRBE are planned to operate until the liquid cryogen is exhausted, while the short wavelength dectors on DIRBE can operate somewhat longer, current estimate is 14 months. DMR is planned to operate for the full 24 months.

COBE SCIENCE

Cosmology, the study of the earliest beginnings and the largest structures in the universe, has been the subject of speculation for thousands of years. Early in the twentieth century a remarkable combination of technology and new physical theory led scientists to put forward the Big Bang theory of the origin and evolution of the universe.

Some 25 years ago that theory received its strongest observational support to date with the discovery of the cosmic background radiation. COBE's mission is to investigate the cosmic background radiation in sufficient detail to uncover the nature of the fundamental processes which have shaped the universe as seen today.

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The first step in the evolution of modern cosmology was development of the general theory of relativity by Albert Einstein. Subsequently, in 1917, Willem de Sitter applied Einstein's equations to the universe as a whole with the startling result that the universe was not required to be static, but instead that the universe was likely in a state of expansion or collapse.

In the 1920's, Edwin Hubble provided the first observational confirmation of this picture through his pioneering work on faint nebulae. Hubble proved that many of the nebulae were galaxies, huge collections of stars similar to the Milky Way galaxy, and also showed that these distant galaxies were receding from the Earth. The nature of the recession was that the farther a galaxy lies from the Earth, the higher is its recessional velocity.

Since the universe was observed to be in a state of expansion, it was natural to deduce that the universe was smaller in the past. In fact, the evidence has led to the astounding conclusion that the galaxies were crowded together into a small, extremely dense volume, whose explosive expansion began some 15 billion years ago and has been dubbed The Big Bang.

In the 1940's, George Gamow, Ralph Alpher and Robert Herman theorized that the early universe was not only extraordinarily dense, but also was extremely hot. This led them to suggest that the nuclear reactions taking place in such a hot, dense environment accounted for the abundances of hydrogen and helium seen in the universe today, together with a small fraction of heavier elements.

Alpher and Herman showed that another consequence of the hot Big Bang theory is that the universe should be filled with the radiation emitted by the hot matter. That is, if scientists can look out in space, back in time to that distant early epoch, then they should see the glow of the initial fireball.

In 1964, Arno Penzias and Robert Wilson of the Bell Telephone Laboratories, using a new and very sensitive microwave receiver and antenna, found an unexplained source of noise or static which came to their antenna equally from all parts of the sky. Their discovery sparked a number of independent observations and theoretical analyses to characterize the background radiation which they had found. Today the evidence is overwhelming that Penzias and Wilson provided the first glimpse back to the primeval fireball which emerged from the Big Bang.

Since the initial measurements, study of the cosmic background radiation has been the subject of hundreds of experiments throughout the world, using ground-based, balloon- and rocket-borne telescopes. Because the radiation is faint and easily distorted by the Earth's atmosphere, the investigation of the relic radiation from such sites is limited confirmation of the general shape of the spectrum and its overall uniformity.

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However, hidden in the details of the spectral shape and spatial distribution of the background radiation are essential clues to the nature of the fundamental processes which shaped the early universe and produced the universe as it appears today.

COBE's instruments are designed to make full use of the vantage point of space to examine the cosmic background radiation with unprecedented sensitivity across a broad range of wavelengths. COBE will scan the sky to look for spatial non-uniformities at a sensitivity level many times what has been possible to date. It will search the spectrum of the relic radiation for deviations from the simplest predicted shape, and it will carefully dissect the radiation at shorter wavelengths to look for evidence of the first stars and galaxies.

COBE's search for variations in the brightness of the cosmic background radiation across the sky is designed to probe the mystery surrounding the formation of galaxies and clusters of galaxies in the universe.

To the present level of measurement accuracy, the background radiation appears smooth, characteristic of an early universe with an extraordinary degree of uniformity in its density and temperature. Yet examination of the present day universe reveals a great deal of non-uniformity: stars are collected into galaxies, galaxies are gathered into clusters and even these gigantic clusters of galaxies may themselves be clustered into even more immense structures. Enormous voids, regions of space with almost no galaxies, exist between the clusters.

Theory indicates that the seeds of this universal structure must have been present in the early universe and the imprint of these seeds must be found as brightness variations in the relic radiation. COBE has the sensitivity to search for the smallest conceivable brightness differences which are consistent with modern theory.

COBE's investigation of the detailed spectral shape of the remnant radiation is motivated by the suggestion that enormously powerful and energetic processes may have taken place in the interval of time after the Big Bang and before the formation of galaxies. For example, if massive black holes existed and swallowed large quantities of matter, the resulting energy release would have been sufficient to distort the spectrum of the fireball radiation to a degree measureable by COBE.

Exotic processes, some of which have been suggested on the basis of modern theories of high energy particle physics, also have the potential of releasing immense quantities of radiative energy into the early universe and distorting the spectrum of the cosmic background radiation. COBE will characterize the shape of the spectrum of the relic radiation at such a level of precision as to allow detailed study of the nature of these postulated energetic events.

COBE's measurement of the diffuse background at wavelengths shorter than those characteristic of the remnant radiation from the initial fireball is intended to look for the radiation from the earliest stages of galaxy and star formation. This faint signature must be detected against the foreground radiation from the solar system, the Milky Way galaxy and other nearby galaxies.

Detection of this signature requires the observational sensitivity and stability that has been carefully engineered into the COBE system. Study of the radiation from the protogalaxies and protostars will aid scientists to probe into the nature of galaxy and star formation.

COBE SCIENCE QUESTIONS

COBE will produce a complete map of the sky at each of 100 different wavelengths to answer three primary questions:

1. What is the variation in brightness of the cosmic background radiation across the sky?

2. Does the cosmic background radiation have the spectrum predicted by contemporary cosmological theory?

3. Can we detect the accumulated light from the first stars and galaxies?

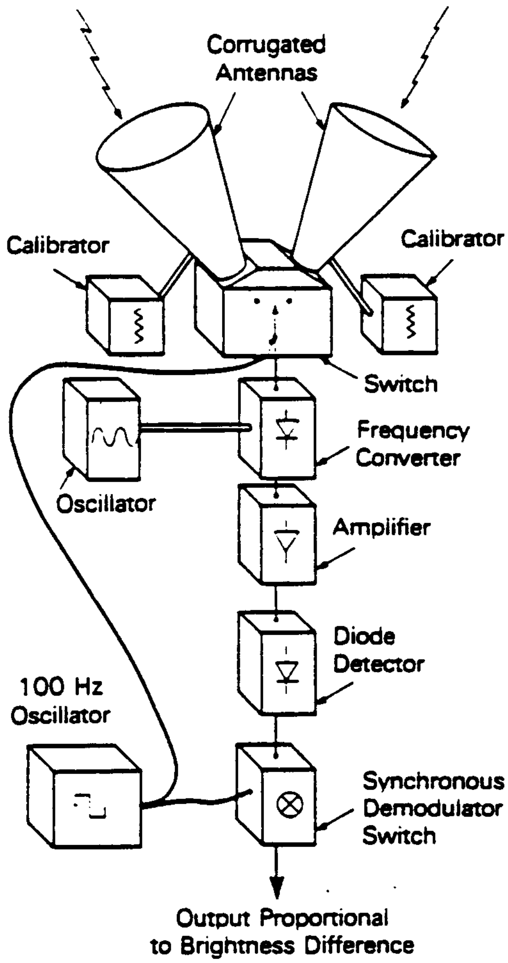
COBE INSTRUMENTS

COBE's three instruments -- the Differential Microwave Radiometer, the Far Infrared Absolute Spectrophotometer and the Diffuse Infrared Background Experiment -- will be able to observe the entire sky at least twice during the nominal mission lifetime of one year.

Differential Microwave Radiometer (DMR)

This instrument will search for minute differences in the brightness of background radiation between different parts of the sky. The DMR is capable of detecting brightness variations that are many times fainter than limits set by current observations and may reveal previously undiscovered physical phenomena.

To distinguish the radiation of our galaxy from the true cosmic background radiation, the DMR will map the sky at three wavelengths: 3.3, 5.7, and 9.6 millimeters. To accomplish this, it will have six receivers, two for each wavelength, mounted so that neither the sun nor Earth will shine directly on them. Each receiver will sensitively measure the difference in microwave power entering two antennae looking at different parts of the sky.



DMR Functional Diagram

Far Infrared Absolute Spectrophotometer (FIRAS)

This instrument will survey the sky to search for deviations in the spectrum of the cosmic background radiation from spectrum predicted on the basis of the simple Big Bang model. FIRAS, as well as the DMR, can resolve the sky into 1,000 separate picture elements and will produce a spectrum for each element. Scientists will be able to compare the spectrum produced by COBE against predicted spectra with at least 100 times better accuracy than ever before.

FIRAS looks out along the spin axis of the spacecraft. It does not scan the sky as rapidly as the other two instruments onboard COBE but will nevertheless scan the entire sky twice during the nominal mission.

FIRAS will detect radiation by using a trumpet-shaped cone antenna. Four detectors, each a tiny silicon resistance thermometer glued to a piece of blackened diamond only one thousandth of an inch thick, are used to detect the radiation collected by the cone antenna. The diamond absorbs the infinitesimal heat from the cosmic background radiation and conducts this heat to the thermometer where the temperature is measured electrically.

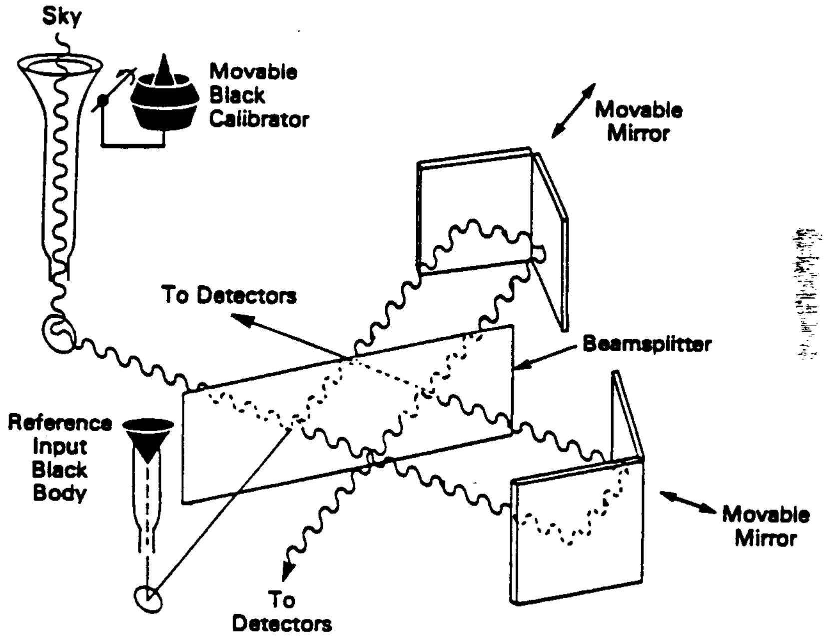
The data collected by FIRAS will be carefully analyzed to determine any deviations from the theoretically predicted spectrum. Even the slightest discrepancy between measurement and theory will have great significance for cosmology.

Diffuse Infrared Background Experiment (DIRBE)

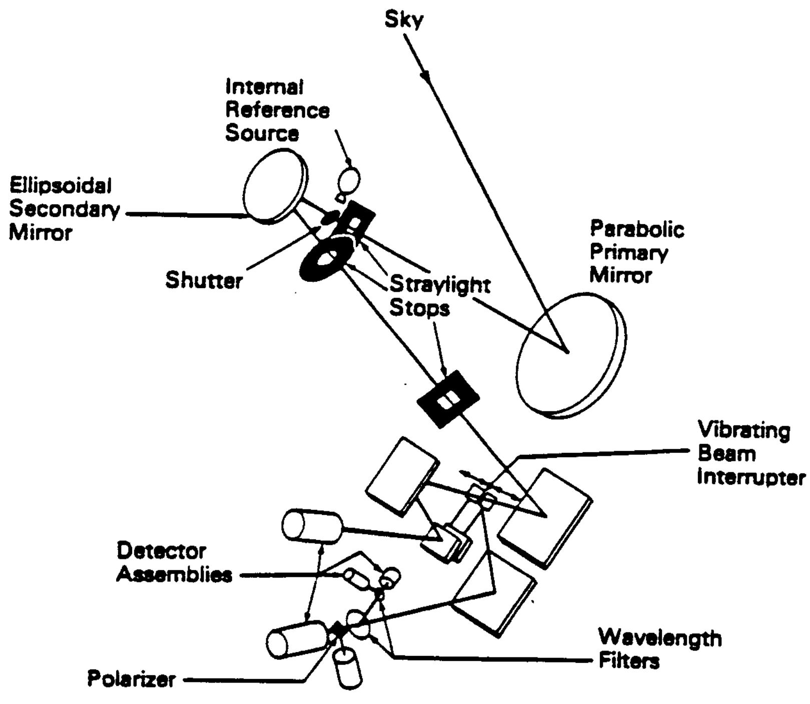
This instrument will search for the light from the earliest stars and galaxies, luminous energy that is thought to have been produced some 200 million years after the Big Bang. DIRBE operates in the infrared part of the spectrum, covering a wavelength range of 1 to 300 micrometers in 10 discrete bands.

It is an off-axis Gregorian telescope with baffles, stops, and super-polished mirrors, which will minimize response to unwanted "stray" light coming from outside its field-of-view. This design allows DIRBE to achieve the measurement accuracy necessary to distinguish between nearby objects and those at cosmological distances.

DIRBE will not focus on a single object, but will instead measure the collective glow of millions of objects. It will measure emission from warm dust in the Solar System and the Milky Way galaxy so precisely that scientists should be able to detect the uniform glow from the first stars and galaxies even if it is only 1 percent as bright as our local celestial environment.



FIRAS Functional Diagram



DIRBE Functional Diagram

Analysis of DIRBE data is complicated by the many kinds of known celestial objects as well as by the motion of the Earth within the interplanetary dust cloud. When analysis is complete, a faint and uniform residual signal may remain after all known sources have been understood and subtracted. The small residue would be the long-sought light of first, primordial objects.

DELTA/COBE LAUNCH VEHICLE PREPARATIONS

The COBE will be launched from Vandenberg Air Force Base, Calif., aboard a Delta expendable launch vehicle by a 90-member NASA/McDonnell Douglas launch team based at NASA's Kennedy Space Center, Fla.

Testing and Modifications

The first stage of the Delta arrived Feb. 9 at Cape Canaveral Air Force Station in Florida. There it underwent mission-specific modifications and electrical testing. This stage is a standard Delta 1 booster upgraded with the Castor 4A strap-on solid rocket motors used on the Delta 2 launch vehicle.

The Delta booster underwent about a month of testing and checkout of its hydraulic, propulsion and electrical systems. Following the completion of modifications and testing, the booster was shipped to Vandenberg Air Force Base, Calif. It arrived there on April 1, to await its scheduled erection on the launch pad.

The Delta second stage arrived at the Cape on Dec. 15, 1988, and underwent electrical and mechanical modifications to support the COBE mission. This included attachment of a retro package containing two propulsion nozzles to allow the stage to back away from the spacecraft following separation. This second stage modification is necessary since the COBE spacecraft does not require a third stage to achieve its final orbit. The Delta second stage was shipped to California in early May.

Before shipment to Vandenberg, the first and second stages were electrically mated for a simulated flight test, an exercise which simulates inflight events. Before shipping the flight vehicle to Vandenberg, a pathfinder vehicle was erected on the launch pad to validate equipment and procedures and also to serve as a "dry run" for pad personnel.

Vehicle Assembly

After arrival in California and temporary storage, the Delta was erected on Space Launch Complex 2-West. The first stage was raised into position on Aug. 16. The nine Castor 4A strap-on solid rockets, which augment thrust during the boost phase, were fastened to the first stage in sets of three beginning on Aug. 14. The second stage was hoisted atop the Delta first stage on Sept. 29.

Launch Pad Refurbishment

KSC personnel have been involved in extensive refurbishment activities at the West Coast launch site for more than 2 years. SLC-2 West has been inactive since the Landsat 5 launch on March 1, 1984.

COBE/Delta Launch Readiness

A Simulated Flight, a post lift-off test which exercises the onboard systems active during ascent, occurred on Oct. 11. Final testing of the vehicle for launch includes first-stage tanking with RP-1 fuel, a highly refined kerosene, and the cryogenic liquid oxygen. This occurred on Oct. 27, together with a practice countdown and launch team certification.

The COBE satellite was scheduled for mating with the Delta vehicle 2 days later to be followed by vehicle/spacecraft integrated testing.

The next significant milestone occurs 3 days before launch with the final loading of the RP-1 propellant. Two days before launch, the second stage will be loaded with storable propellants. The liquid oxygen is loaded during the terminal count beginning at the T-75 minute mark.

NASA has been launching the Delta rocket since 1960. Delta/COBE is the final official NASA launch of a NASA-owned Delta vehicle.

COBE MISSION MANAGEMENT

The Office of Space Science and Applications (OSSA), NASA Headquarters, is responsible for the overall direction and evaluation of the COBE Program. The Director of the Astrophysics Division has the Headquarter responsibility for COBE.

The Goddard Space Flight Center (GSFC) has Project Management responsibility for the design, development, testing, operation and analysis of the data. The Office of Space Operations, NASA Headquarters, has overall tracking and data acquisition responsibility. The Delta launch vehicle project management is the responsibility of GSFC as part of the NASA Expendable Launch Vehicle Program under the Office of Space Flight. The responsible personnel within these areas are:

L.A. Fisk, Associate Administrator for Space Science and Applications
A.V. Diaz, Deputy Associate Administrator for Space Science and Applications
C.J. Pellerin, Jr., Program Director
D.A. Gilman, Program Manager
L. Caroff, Program Scientist

W.B. Lenoir, Associate Administrator for Space Flight
J.B. Mahon, Deputy Associate Administrator for Space Flight
C.R. Gunn, Director, Unmanned Launch Vehicles and Upper Stages
P.T. Eaton, Chief, Small and Medium Launch Vehicles Branch
C.T. Force, Associate Administrator for Space Operations
J.W. Townsend, Jr., Center Director, GSFC
J.H. Trainor, Associate Director, GSFC
Peter Burr, Director, Flight Projects
D.L. Fahnestock, Director of Mission Operations and Data Analysis, GSFC
J.R. Busse, Director of Engineering, GSFC
R. Mattson, COBE Project Manager, GSFC
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J.C. Mather, Project Scientist and Principal Investigator for FIRAS, GSFC
N.W. Boggess, Deputy Project Scientist for Data, GSFC
D.K. McCarthy, Deputy COBE Project Manager, GSFC
J. Peddicord, Deputy Project Manager/Resources, GSFC
J.F. Turtil, Systems Engineer, GSFC
A.D. Fragomeni, Observatory Manager, GSFC
E.W. Young, Instruments Manager, GSFC
J.L. Wolfgang, Software Systems Manager, GSFC
R.G. Sanford, Mission Operations Manager, GSFC
Gen. F. S. McCartney, Center Director, KSC
J.T. Conway, Director, Payload Management and Operations
J.L. WomackDirector, Expendable Vehicles
S.M. Francois, Chief, Launch Operations Division
L. J. Holloway, Director, McDonnell Douglas Space Systems, Cape Canaveral Air Force Station.

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Dr. Robert F. Silverberg, GSFC
Dr. George F. Smoot, University of California at Berkeley, Principal Investigator for DMR

Dr. Rainer Weiss, Massachusetts Institute of Technology, Chairman of Science Working Group
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Dr. Edward L. Wright, University of California, Los Angeles, Data Team Leader

CONTRACTORS

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Ball Aerospace Systems Div. P.O. Box 1062, Boulder, CO	Dewar
Solarex 1335 Piccard Drive Rockville, MD 20850	Solar Arrays
McDonnell Douglas Astronautics Co. P.O. Box 516 St. Louis, MO 63166	Batteries Delta Launch Vehicle Launch Support Services
Motorola, Inc. 2501 S. Price Road Chandler, AZ 85248	Transponder
Ball Aerospace Systems Division Communications Systems Colorado Engineering Center 10 Longs Peak Drive Broomfield, CO 80020	Antenna
Gulton Industries, Inc. 6600 Gulton, NE Albuquerque, NM 87109	Command/data handling
General Electric Bldg. 10-5-3 Front and Cooper Camden, NJK 18102	Tape recorder
Engineering and Economic Research 10289 Aerospace Road Seabrook, MD 20706	Harness
Information Development and Applications, Inc. 10759 Tucker St. Beltsville, MD 20705	Instrument electronics
Digital Equipment Corp. 8301 Professional Pl. Landover, MD 20785	Instrument ground support equipment

ST System Corp. 4400 Forbes Blvd. Lanham, MD 20706	Software
Barnes Engineering Company 88 Longhill Cross Roads P.O. Box 867 Shelton, CT 06484	Earth scanner assembly
Applied Physics Laboratory Johns Hopkins Road Laurel, MD 20707	Momentum management assembly
Bendix Field Engineering Company Teterboro, NJ 07608	Reaction wheels
ADCOLE Corporation 669 Forest St. Marlkborough, MA 01752	Sun sensors
Northrop Precision Products Div. 100 Morse St., Norwood, MA 02062	Gyros
Northrop Services, Inc. 108 Powers Court, Sterling, VA	Integration and test
Swales 5050 Powder Mill Road, Beltsville, MD	Mechanical design

- end -

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(Phone: 301/286-5566)

For Release:
November 8, 1989

N89-74

NOTE TO EDITORS: COBE MEDIA BRIEFING SET

A media briefing on the Cosmic Background Explorer (COBE) spacecraft will be held at the Jet Propulsion Laboratory (JPL), Pasadena, Calif., at 2:00 p.m. EST, Tuesday, Nov. 14.

COBE is scheduled for launch aboard a Delta expendable launch vehicle on Nov. 17, 1989, from space launch complex 2-West, Vandenberg Air Force Base, Calif. The 30-minute launch window for that day opens at 9:24 a.m. EST.

COBE, with a complement of three scientific instruments, is designed to study the origin and dynamics of the universe, including the theory that the universe began about 15 billion years ago with a cataclysmic explosion -- the Big Bang.

Background information on the spacecraft and its mission, including a press release, photograph and videotape, will be available during the briefing.

The briefing will be carried on NASA Select TV, SATCOM F-2R, transponder 13, 72 degrees west longitude. Two-way (interactive) question and answer capability will be available at JPL, NASA Headquarters and most NASA field centers.

- end -

NASA News

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For Release:
November 13, 1989

RELEASE: 89-173

FINDINGS RELEASED ON ORBITER PROCESSING FACILITY WATER MISHAP

An investigation board at NASA's John F. Kennedy Space Center (KSC), Fla., has determined that human error caused the release of water from a Firex deluge system in Orbiter Processing Facility (OPF) bay 2 on Sept. 24 while workers were preparing the orbiter Columbia for its next mission.

Water damage to the exposed flight hardware and associated ground support equipment is still being assessed, but appears to be minimal. The mishap is not expected to impact Columbia's readiness for the STS-32 mission in December.

The board found that the primary cause of the mishap was the failure of water technicians to follow procedural instructions during the repair of a water valve in the deluge system. The board also cited as a contributing cause the lack of training by OPF "contingency team" members in the operation of the OPF water deluge system.

The incident was initiated by a sequence of events that occurred following the repair of a defective valve in Zone 3 of the seven-zone OPF water deluge system. Water technicians added a non-procedural flow test on the Zone 3 system by cycling flow valves. This allowed water to flow at a reduced rate (20-30 percent of normal flow) into Zone 3 of the deluge system, resulting in the release of water in the work area of the OPF.

Meanwhile, OPF technicians, who were members of the facility's "contingency team", had proceeded to the manual activation station behind OPF bay 2 in an attempt to shut off the flow, unaware that the Zone 3 water flow had already been isolated and deactivated.

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Believing that the arming and firing valves for the water zones were in the "on" position rather than the "off" position, they mistakenly activated Zones 1 through 5 to the "full on" position, initiating a second and heavier flow of water from Zones 1, 2, 4 and 5 into the OPF work area. The water flow subsequently was shut down by water technicians.

The investigation board has recommended that KSC take the following corrective actions: (1) ensure that personnel with access to the OPF water deluge system are fully trained and certified in the operation of the system; (2) develop and rigorously implement a policy outlining which operations and activities involving the water deluge system require thorough pre-task briefings; (3) orient the system's control panels to the industry norm and label them with specific open and closed markings; and (4) provide positive control to limit access to the system's control panels.

The investigation board was chaired by Thomas Utsman, KSC deputy director. Other board members were Charles Henschel, Shuttle Operations; Linda Hannett, Safety, Reliability and Quality Assurance; and Norm Starkey, NASA Headquarters. Affiliated members were Ronald Gillett, Safety Advisor and Recorder; Douglas Hendriksen, Legal Advisor; and Dick Young, Public Affairs Advisor.

- end -

Editors Note: A copy of the board's report is available for review in the newsrooms at NASA Headquarters and the Kennedy Space Center.

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For Release:
November 14, 1989

RELEASE: 89-174

SPACE EXPOSED TOMATO SEEDS ARE COMING HOME

NASA is offering 12.5 million tomato seeds to budding student gardeners in the first experiment ever to study the effects of long-term space exposure on living tissue.

It has been more than 5-1/2 years since the Space Shuttle deployed 12.5 million tomato seeds, housed in the Long Duration Exposure Facility (LDEF), into Earth orbit. Next month during Space Shuttle mission 32, NASA plans to retrieve the 11-ton, free-flying satellite. LDEF carries 57 experiments concerned with the exposure of materials to the space environment, one of which is SEEDS.

SEEDS (Space Exposed Experiment Developed for Students) is a cooperative educational partnership among NASA Headquarters Education Affairs Division, Washington, D.C., NASA's Langley Research Center, Hampton, Va., and the George W. Park Seed Co., Greenwood, S.C.

The project is designed as a classroom experiment for U.S. students in grades 5 through university to conduct open-ended research.

NASA Administrator Richard H. Truly said, "Because this is the first opportunity for long-duration space exposure of living tissues, every classroom experiment will be significant. I hope millions of students will experience this hands-on, one-of-a-kind experiment and learn that science is fun."

The SEEDS project has the potential to directly involve 4 million students and 40,000 educators, in 250,000 classrooms.

After LDEF is retrieved, the flight seeds will be returned to Park Seed Co. where an equal number of control seeds from the same lot have been maintained in a ground-based facility.

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Following preliminary growth tests conducted by plant scientists, these seeds will be distributed in late February. Each seed kit will contain 50 flight seeds and 50 control seeds, instructional materials and computerized data collection and reporting booklets.

Students will conduct classroom experiments, including experiment design, data gathering, sample comparison and final reporting results. Upper elementary and secondary levels could compare germination rates and times, seed embryos, phototropic responses and fruit products. Students also could consider the impact of varying environmental factors. Upper secondary and university students could perform chromosome experiments and population genetics studies.

The tomato seed was chosen because students in all geographic areas are familiar with the plant; it is relatively simple to germinate and grow; it is small enough to permit a large number to be flown; and it is proven to be very hardy. Rutgers tomato seeds are open-pollinated, nonhybrids and produce plants with comparatively little variation from generation to generation. Consequently, any changes in the space tomatoes' characteristics will be easy to detect. The Rutgers tomato seed was selected because it has wide adaptation and can be grown in every state.

The SEEDS project gives students the unprecedented opportunity to be involved in a national, first-of-a-kind experiment that encourages both active involvement and an interdisciplinary approach to designing their own investigations to involve decision-making, data-gathering and reporting of final results.

There is still time to participate in the SEEDS project. Educators wishing further information in order to participate in the program should contact the NASA SEEDS Project, Educational Affairs Division, Code XEO, NASA, Washington, D.C. 20546, and indicate education/grade level.

- end -

NASA News

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For Release:
November 17, 1989

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RELEASE: 89-175

RESEARCH FLIGHT RESULTS MAY AID FUTURE AIRCRAFT DESIGNS

NASA is using initial data from the first phase of a research program studying airflow during high angle-of-attack flight to validate computer codes and wind tunnel results that should significantly improve design capabilities for future aircraft.

The High Angle-of-Attack Research Program at NASA's Ames-Dryden Flight Research Facility, Edwards, Calif., uses an F/A-18 Hornet aircraft on loan from the U.S. Navy. NASA expects the effort to provide information that will lead to increases in maneuverability and make high-performance aircraft safer to fly.

"Angle-of-attack" (or "alpha") is an engineering term for the angle of an aircraft's body and wings relative to its actual flight path. During maneuvers, pilots often fly at extreme angles-of-attack with the nose pitched up while the aircraft continues in its original direction. This can lead to conditions in which the airflow around the aircraft becomes separated from normal flow paths, and the wings do not produce sufficient lift for the aircraft to maintain altitude.

Currently, the extreme complexity of separated airflows encountered on fighter aircraft at high angles-of-attack cannot be modeled adequately during the design process. As a result, an airplane's high-alpha characteristics remain an estimate until it enters development and flight operations. Information from the F/A-18 program will give engineers a better understanding of airflow phenomena over an aircraft's fuselage, wings and tail surfaces at various flight angles and will help engineers to improve control effectiveness on future high-performance aircraft.

- more -

"The data we have obtained in the first phase of the program is being used to improve the computational models," said Don Gatlin, Ames-Dryden's F/A-18 High Angle-of-Attack Program Manager. "And from what we've seen, they compare well with wind tunnel data obtained at Langley Research Center and Ames Research Center."

The first phase of the NASA study involved more than 100 research flights at up to 55 degrees angle-of-attack. Separate visual studies of the airflow were made with smoke, cloth tufts attached to the F/A-18's exterior surface and an oil-based dye released from small orifices at the nose of the aircraft. Flow patterns recorded on film, videotape and on the aircraft's surface were compared with computer and wind tunnel predictions. Data also were obtained from an instrumentation system that included pressure sensors installed in a 360-degree pattern around the nose of the aircraft and at many other locations on the aircraft.

The high angle-of-attack study is scheduled to begin Phase Two flights next spring. Three thrust vectoring vanes will be installed around each of the exhaust nozzles of the F/A-18's two jet engines. The movable vanes will change the direction of the engines' exhaust thrust and help to control and stabilize the research aircraft when its rudders, ailerons and elevators become less effective during flights at angles-of-attack up to 70 degrees. Phase Two will continue through the end of summer 1991.

The program is being conducted by NASA's Ames Research Center, Moffett Field, Calif., Langley Research Center, Hampton, Va., and Lewis Research Center, Cleveland.

- end -

EDITOR'S NOTE: A video clip showing flight operations with the F/A-18 High-Alpha Research Vehicle is available (202/453-8594). Photographs also are available to illustrate this release (202/453-8375):

Color: 89-HC-229 B&W: 89-H-229
89-HC-347

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202-453-8400

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For Release:
November 15, 1989

RELEASE: 89-176

NASA HEADS HYDROGEN FUEL TECHNOLOGY EFFORT FOR AERO-SPACE PLANE

When the proposed National Aero-Space Plane (NASP) leaves the runway sometime in the 1990's, the fuel that powers it may be largely the result of technology efforts being coordinated today by NASA Lewis Research Center, Cleveland.

NASP is a joint NASA/Department of Defense program with the ultimate goal of developing an air-breathing experimental flight vehicle designated the X-30. The X-30 will take off horizontally, fly directly into orbit, then land like a conventional aircraft. It also may have the capability to cruise through the atmosphere at sustained hypersonic (above Mach 5) speeds.

Researchers are focusing on "slush" hydrogen, a high-energy hydrogen slurry, as the primary propellant for NASP. It is denser than liquid hydrogen and requires smaller tanks for the same amount of propulsive capability. The tanks themselves can be lighter in weight because slush hydrogen requires an internal pressurization of only 1 pound per square inch. Also, slush hydrogen is a better coolant for the vehicle and engines than liquid hydrogen.

Using slush instead of liquid hydrogen "reduces the size of the NASP and reduces the projected gross liftoff weight by up to 30 percent," according to Ned Hannum, Deputy Chief of the Space Propulsion Technology Division, Lewis Research Center.

The slush hydrogen technology development team, headed by Lewis Research Center, was formed about 3 years ago when very little was known about the material's properties. Each team member is assigned a specific area of research.

- more -

o The National Institute of Standards and Technology (NIST) is investigating instrumentation, the physical properties of slush hydrogen and production methods. NIST also has a historical data base and experience in slush hydrogen production and pumping.

o McDonnell Douglas and its subcontractors, Air Products, Martin Marietta and Wyle Laboratories, are performing large-scale experimental work in slush production, pressurization, transfer and flow modeling.

o The University of Michigan is working on the gelation of hydrogen and slush hydrogen. Gelated hydrogen probably will not be available for NASP, but may help control sloshing of hydrogen fuels in the propellant tanks of future flight vehicles.

o The University of Colorado is studying slush hydrogen thermal acoustic oscillation phenomena.

o The Los Alamos National Laboratory is investigating the safety aspects of slush hydrogen, including the levels of oxygen contamination that will be acceptable in slush hydrogen propellants.

As part of the in-house activity at Lewis, Air Products has constructed the slush maker at Lewis' Plum Brook Station near Sandusky, Ohio. The plant, slated to begin operation late this winter, will be capable of producing slush hydrogen in 800-gallon batches. The slush facility will allow researchers to explore production, transfer and storage of slush. Lewis' experimental efforts are a major portion of the overall slush hydrogen program.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202-453-8400

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For Release:
Nov. 28, 1989

RELEASE: 89-177

GLOBE EXPERIMENT MEASURES WIND VELOCITY, DIRECTION

A DC-8 aircraft from NASA's Ames Research Center, Mountain View, Calif., is conducting airborne research over the Pacific Ocean to support development of a satellite meteorology instrument scheduled for launch in the late 1990s. The GLOBE (Global Backscatter Experiment) survey flight is measuring the number and size distribution of atmospheric particles, called aerosols, over remote areas of the tropical Pacific and the northern and southern hemispheres.

The Nov. 6-Dec. 1 expedition of NASA, the National Oceanic and Atmospheric Administration (NOAA) and university investigators is collecting data between California and Japan, penetrating both polar regions. Fourteen flights are surveying areas believed to contain the lowest average global aerosol counts overall during periods of maximum and minimum dust concentration.

The expedition is collecting baseline data for the development of the Laser Atmospheric Wind Sounder (LAWS) instrument. When carried on the proposed Earth Observing System (EOS) in polar orbit, LAWS will measure the Doppler shift of aerosol spectra to indicate global wind velocities and directions. As a whole, EOS will provide on-orbit measurements of global climate processes and global water, biological and geochemical cycles.

The measurement of global winds from polar orbit will advance weather forecasting capability, especially over the South Pacific and other regions where ground-based measurements are impossible. Current methods track wind directions and speed through satellite infrared images of clouds, but that data provides limited information about overall atmospheric circulation.

Four experiments aboard the DC-8 involve direct aerosol sampling at the aircraft's altitude of 27,000 feet. The experiments measure amounts of particles 1/100th the diameter of a human hair (1 micron) as well as their optical, physical and chemical properties. Three experiments use lidar to remotely sense particulates at altitudes from 1,000 to 40,000 feet. Lidar is similar to radar but uses visible or infrared light in place of radio waves. The lidar instruments, operating at different wavelengths, will measure the energy reflected back (backscatter) by the atmospheric aerosols.

The lead instrument is a pulsed carbon dioxide lidar from the Jet Propulsion Laboratory, Pasadena, Calif., supported by lidars from Goddard Space Flight Center, Greenbelt, Md., and Marshall Space Flight Center (MSFC), Huntsville, Ala. Research aircraft from Japan, Australia and New Zealand are providing additional measurements coordinated with the DC-8 flights.

Dr. Ramesh Kakar of the Office of Space Science and Applications, NASA Headquarters, is the GLOBE program manager. Project manager is Dr. James E. Arnold of MSFC. Dean N. Jaynes of the Ames Research Center is mission manager. The GLOBE mission was developed by the Earth Science and Application Division at MSFC. The DC-8 is managed for the NASA Office of Space Science and Applications by the Science and Aircraft Applications Division at Ames.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202-453-8400

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For Release:
November 20, 1989

RELEASE: 89-178

U.S./USSR SOLAR SYSTEM JOINT WORKING GROUP MET IN MOSCOW

The third meeting of the U.S./USSR Joint Working Group (JWG) on Solar System Exploration was held Nov. 13-18, 1989, in Moscow. The Soviet delegation was headed by the Director of the Vernadsky Geochemical Institute of the USSR Academy of Sciences, Academician V.L. Barsukov. The U.S. delegation was headed by Samuel W. Keller, NASA Associate Deputy Administrator.

During the meeting, specialists of both sides noted that at the present time the continued exploration of the planet Mars is of primary interest. To increase the scientific return of these and other planetary missions, they agreed to coordinate scientific programs and studies planned in the Soviet Union and the United States. They also agreed on the participation of Soviet and U.S. scientists as co-investigators in each other's projects and on the exchange of scientific data from these missions.

The participants at the meeting held a preliminary discussion of studies required to establish scientific goals for lunar science.

The next meeting of the JWG is scheduled for fall 1990 in Washington, D.C. The JWG was established under the U.S./USSR Space Science Cooperation Agency signed in April 1987.

- end -

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202-453-8400

Jim Kukowski
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For Release:
December 1, 1989

RELEASE: 89-179

NASA ANNOUNCES IMPLEMENTATION OF DRUG FREE WORKPLACE PROGRAM

NASA announced today that, in support of President Bush's "National Drug Control Strategy", the agency will implement its Drug-Free Workplace Program, effective Jan. 5, 1990.

The program places a strong emphasis on education, training and assistance through the NASA Employee Assistance Program. A limited number of employees will be subject to random drug testing as a means of ensuring a continuing drug-free workplace environment.

Under NASA's program, each employee who is an illegal drug user, has the opportunity to voluntarily identify himself/herself and to receive counseling and rehabilitation.

An employee will not be disciplined for illegal drug use if the employee voluntarily requests help before he/she is found to be using illegal drugs by other means such as random testing; successfully completes counseling or rehabilitation; and thereafter refrains from use of illegal drugs.

Those employees subject to random testing occupy "sensitive" positions as defined in the NASA program and determined by agency management.

Included among NASA's sensitive positions are: senior-level management officials, including the administrator and his deputy; all center directors; flight related personnel such as astronauts, pilots, mission and payload specialists, flight controllers, test directors and other scientific, engineering and support personnel involved in the execution of manned and unmanned flight-related activities.

The program also includes, under certain situations, drug testing if there is reasonable suspicion of illegal drug use or an accident or unsafe practice. All drug testing will be conducted in accordance with the mandatory guidelines for Federal workplace drug testing programs issued by the Department of Health and Human Services.

-end-

SPACE SHUTTLE MISSION STS-32
PRESS KIT

DECEMBER 1989

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STS-32 QUICK LOOK

Launch Date and Site: Dec. 18, 1989
Kennedy Space Center, Fla. Pad 39-A.

Launch Window: 6:46 p.m. - 7:48 p.m. EST

Orbiter: Columbia (OV-102)

Orbit: 190 nm altitude; 28.5 degrees inclination

Landing Date/Time: Dec. 28, 1989/4:21 p.m. EST

Primary Landing Site: Edwards AFB, Calif.

Abort Landing Sites:
Return to Launch Site - Kennedy Space Center
Transoceanic Abort Landing - Ben Guerir, Morocco
Abort Once Around - Edwards AFB

Crew:
Daniel C. Brandenstein, Commander
James D. Wetherbee, Pilot
Bonnie J. Dunbar, Mission Specialist
Marsha S. Ivins, Mission Specialist
G. David Low, Mission Specialist

Cargo Bay Payloads:
Syncom IV-F5 (primary payload); RMS for LDEF Retrieval

Middeck Payloads:
Characterization of Neurospora Circadian Rhythms (CNCR)
Protein Crystal Growth (PCG)
Fluid Experiment Apparatus (FEA)
American Flight Echocardiograph (AFE)
Latitude/Longitude Locator (L3)
IMAX

NASA
National Aeronautics and
Space Administration

Washington, D.C.
20546

RELEASE: 89-180

SYNCOM IV DEPLOY, LDEF RETRIEVAL HIGHLIGHT 10-DAY COLUMBIA FLIGHT

Highlights of Space Shuttle mission STS-32, the 33rd flight of the National Space Transportation System, will be deployment of a Navy synchronous communications satellite (Syncom IV) and retrieval of the Long Duration Exposure Facility (LDEF) launched aboard Challenger on mission STS-41C in April 1984.

Syncom IV-F5 is the last in a series of five Navy satellites built by Hughes Communications Services Inc. It is designed to provide worldwide, high-priority communications between aircraft, ships, submarines and land-based stations for the U.S. military services and the Presidential Command Network. Syncom measures 15 feet long and 13 feet in diameter.

After Syncom deployment using the "Frisbee" method, the crew will do a Shuttle separation burn maneuver away from the satellite. A solid rocket perigee kick motor along with several liquid apogee motor firings will boost the satellite to geosynchronous orbit.

The LDEF, a 12-sided, open-grid structure made of aluminum rings and longerons, is 30 feet long, 14 feet in diameter and weighs 8,000 pounds. Retrieval of the LDEF will be accomplished by the orbiter's remote manipulator system (RMS) arm. Once the rendezvous portion of the mission is completed, Mission Specialist Bonnie Dunbar will grapple the LDEF with the end effector of the RMS and maneuver LDEF into the five support trunnion latches in the payload bay of Columbia.

The LDEF experiments range in research interest from materials to medicine to astrophysics. All required free-flying exposure in space without extensive electrical power, data handling or attitude control systems. Many of the experiments are relatively simple with some being completely passive while in orbit. The structure was designed for reloading and reuse once returned to Earth.

Orbital data on the LDEF is provided to NASA by the North American Aerospace Defense Command (NORAD). Intensive C-band radar tracking will begin approximately 72 hours before launch to provide the accurate data required for orbiter and LDEF rendezvous.

Joining Syncom IV—and later LDEF—in the payload bay of Columbia will be the Interim Operational Contamination Monitor (IOCM). This is an automatic operation system for the measurement of contamination that may be present in the payload bay for the entire mission duration. It is designed to provide continuous measurement of collected particulate and molecular mass at preprogrammed collection surface temperatures.

Columbia also will carry several secondary payloads involving material crystal growth, microgravity protein crystal growth, lightning research, in-flight cardiovascular changes and effects of microgravity and light on the cellular processes that determine circadian rhythms and metabolic rates.

Commander of the mission is Daniel C. Brandenstein, Captain, USN. James D. Wetherbee, Lieutenant Commander, USN, is pilot. Brandenstein was pilot on mission STS-8 in August 1983 and commander of STS-51G in June 1985. Wetherbee will be making his first Shuttle flight.

Mission specialists are Bonnie J. Dunbar, Ph.D; Marsha S. Ivins and G. David Low. Dunbar previously flew as a mission specialist on STS-61A in October 1985. Ivins and Low will be making their first Shuttle flights.

Liftoff of the ninth flight of Columbia is scheduled for 6:46 p.m. EST on December 18 from Kennedy Space Center, Fla., launch pad 39-A, into a 190-nautical mile, 28.5 degree orbit.

A final decision on launch time will be made approximately 12 hours prior to lauch. The decision will be based on the latest tracking data for the LDEF and allow for appropriate adjustment of Orbiter inflight computers.

Nominal mission duration is expected to be 9 days, 21 hours 35 minutes. Deorbit is planned on orbit 158, with landing scheduled for 4:21 p.m. EST, depending on actual launch time, on December 28 at Edwards Air Force Base, Calif.

The launch window for this mission is dictated by vehicle performance, real-time LDEF rendezvous data and the reentry track of the external tank.

GENERAL INFORMATION

NASA Select Television Transmission

NASA Select television is available on Satcom F-2R, Transponder 13, located at 72 degrees west longitude.

The schedule for orbiter transmissions and change-of-shift briefings from Johnson Space Center, Houston, will be available during the mission at Kennedy Space Center, Fla.; Marshall Space Flight Center, Huntsville, Ala.; Johnson Space Center; and NASA Headquarters, Washington, D.C. The schedule will be updated daily.

Schedules also may be obtained by calling COMSTOR, 713/483-5817. COMSTOR is a computer data base service requiring the use of a telephone modem. A voice update of the TV schedule may obtained by dialing 202/755-1788. This service is updated daily at noon EST.

Special Note to Broadcasters

In the five workdays before launch, short sound bites of STS-32 crew interviews will be available by calling 202/755-1788 between 8 a.m. and noon.

Status Reports

Status reports on countdown, mission progress and landing operations will be produced by the appropriate NASA news center.

Briefings

A press-briefing schedule will be issued before launch. During the mission, flight control personnel will be on 8-hour shifts. Change-of-shift briefings by the off-going flight director will occur at approximately 8-hour intervals.

LAUNCH PREPARATIONS, COUNTDOWN AND LIFTOFF

Processing of Columbia for the STS-32 mission began on Aug. 21, when the spacecraft was towed to Orbiter Processing Facility (OPF) Bay 2 after arrival from Dryden Flight Research Facility. Post-flight deconfiguration of STS-28, Columbia's previous mission, and inspections were conducted in the hangar.

Approximately 26 modifications have been implemented since the STS-28 mission. One of the more significant added a fifth tank set for the orbiter's power reactant storage and distribution system. This will provide additional liquid hydrogen and liquid oxygen, which combine in the fuel cells to produce electricity for the Shuttle and water as a by-product. With the addition of the fifth tank, the mission duration has been planned for 10 days.

Improved controllers for the water spray boilers and auxiliary power units were also installed. Other improvements were made to the orbiter's structure and thermal protection system, mechanical systems, propulsion system and avionics system.

Columbia was transferred from the OPF to the Vehicle Assembly Building (VAB) on Nov. 16 for mating to the external tank and SRBs. The assembled Space Shuttle was rolled out of the VAB aboard its mobile launcher platform (MLP) for the 3.4-mile trip to Launch Pad 39-A on Nov. 28. STS-32 will mark the first use of MLP-3 in the Shuttle program and the first use of Pad A since mission 61-C in January 1986.

The countdown for Columbia's ninth launch will pick up at T-minus 43-hours. The launch will be conducted by a NASA-and-industry team from Firing Room 1 in the Launch Control Center.

SPACE SHUTTLE ABORT MODES

Space Shuttle launch abort philosophy aims for safe and intact recovery of the flight crew, the orbiter and its payload. Abort modes include:

• Abort-To-Orbit (ATO): Partial loss of main engine thrust late enough to permit reaching a minimal 105-nautical-mile orbit with orbital maneuvering system engines.

• Abort-Once-Around (AOA): Earlier main engine shutdown with the capability to allow one orbit around before landing at Edwards Air Force Base, Calif.; White Sands Space Harbor (Northrup Strip), N.M.; or the Shuttle Landing Facility (SLF) at Kennedy Space Center, Fla.

• Trans-Atlantic Abort Landing (TAL): Loss of two main engines midway through powered flight would force a landing at Ben Guerir, Morocco; Moron, Spain; or Banjul, The Gambia.

• Return-To-Launch-Site (RTLS): Early shutdown of one or more engines and without enough energy to reach Ben Guerir, would result in a pitch around and thrust back toward KSC until within gliding distance of the SLF.

STS-32 contingency landing sites are Edwards AFB, White Sands, Kennedy Space Center, Ben Guerir, Moron and Banjul.

MAJOR COUNTDOWN MILESTONES

T-43 Hours (43:00:00)
• Verify that the Space Shuttle is powered up.

T-34:00:00
• Continue orbiter and ground support equipment closeouts for launch.

T-30:00:00
• Activate orbiter's navigation aids.

T-27:00:00 (holding)
• Enter the first built-in hold for eight hours.

T-27:00:00 (counting)
• Begin preparations for loading fuel cell storage tanks with liquid oxygen and liquid hydrogen reactants.

T-25:00:00
• Load the orbiter's fuel cell tanks with liquid oxygen.

T-22:30:00
• Load the orbiter's fuel cell tanks with liquid hydrogen.

T-22:00:00
• Perform interface check between Houston Mission Control and the Merritt Island Launch Area (MILA) tracking station.

T-20:00:00
• Activate inertial measurement units (IMUs).

T-19:00:00 (holding)

- Enter the 8-hour built-in hold.
- Activate orbiter communications system.

T-19:00:00 (counting)

- Resume countdown.
- Continue preparations to load the external tank, orbiter closeouts and preparations to move the Rotating Service Structure.

T-11:00:00 (holding)

- Start built-in hold, duration dependent on launch time.
- Perform orbiter ascent switch list in the orbiter flight and middecks.

T-11:00:00 (counting)

- Retract Rotating Service Structure from vehicle to launch position. (Could occur several hours earlier if weather is favorable.)

T-9:00:00

- Activate orbiter's fuel cells.

T-8:00:00

- Configure Mission Control communications for launch.
- Start clearing blast danger area.

T-6:30:00

- Perform Eastern Test Range open loop command test.

T-6:00:00 (holding)

- Enter one-hour built-in hold. Receive mission management "go" for tanking.

T-6:00:00 (counting)

- Start external tank chilldown and propellant loading.

T-5:00:00

- Start IMU pre-flight calibration.

T-4:00:00

- Perform MILA antenna alignment.

T-3:00:00 (holding)

- Begin two-hour built-in hold.
- Complete external tank loading and ensure tank is in a stable replenish mode.
- Ice team goes to pad for inspections.
- Closeout crew goes to white room to begin preparing orbiter's cabin for flight crew's entry.
- Wake flight crew (actual time launch minus 4:55:00).

T-3:00:00 (counting)

- Resume countdown.

T-2:55:00

- Flight crew departs O&C Building for Launch Pad 39-A (Launch minus 3:15:00).

T-2:30:00

- Crew enters orbiter vehicle (Launch minus 3:15:00).

T-00:60:00
• Start pre-flight alignment of IMUs.

T-00:20:00 (holding)
• 10-minute built-in-hold begins.

T-00:20:00 (counting)
• Configure orbiter computers for launch.

T-00:10:00
• White room closeout crew cleared through the launch danger area roadblocks.

T-00:09:00 (holding)
• Begin 10-minute built-in-hold.
• Perform status check and receive Launch Director and Mission Management Team "go."

T-00:09:00 (counting)
• Start ground launch sequencer.

T-00:07:30
• Retract orbiter access arm.

T-00:05:00
Pilot starts auxiliary power units.
• Arm range safety, SRB ignition systems.

T-00:03:30
• Place orbiter on internal power.

T-00:02:55
• Pressurize liquid oxygen tank for flight and retract gaseous oxygen vent hood.

T-00:01:57
• Pressurize liquid hydrogen tank.

T-00:00:31
• "Go" from ground computer for orbiter computers to start the automatic launch sequence.

T-00:00:28
• Start solid rocket booster hydraulic power units.

T-00:00:21
• Start SRB gimbal profile test.

T-00:00:06.6
• Main engine start.

T-00:00:03
• Main engines at 90 percent thrust.

T-00:00:00
• SRB ignition, aft skirt holddown post release and liftoff.
• Flight begins and control switches to Houston.

TRAJECTORY SEQUENCE OF EVENTS

EVENT	MET (d/h:m:s)	RELATIVE VELOCITY (fps)	MACH	ALT. (ft)
Launch	00/00:00:00			
Begin Roll Maneuver	00/00:00:09	159	.14	604
End Roll Maneuver	00/00:00:15	311	.28	2,165
SSME Throttle Down to 65 percent	00/00:00:28	663	.61	8,313
Max. Dyn. Pressure (Max Q)	00/00:00:52	1,171	1.10	26,751
SSME Throttle Up to 104 percent	00/00:00:59	1,323	1.27	33,602
SRB Staging	00/00:02:06	4,138	3.75	157,422
Negative Return	00/00:04:05	7,100	7.61	339,500
Main Engine Cutoff (MECO)	00/00:08:34	24,543	22.88	362,696
Zero Thrust	00/00:08:40	24,557	22.59	364,991
ET Separation	00/00:08:52			
OMS 2 Burn	00/00:40:27			
Syncom IV-F5 Deploy (orbit 17)	01/00:44:00			
Deorbit Burn (orbit 158)	09/20:38:17			
Landing (orbit 159)	09/21:34:44			

Apogee, Perigee at MECO: 186 x 34
Apogee, Perigee at post-OMS 2: 190 x 160*
Apogee, Perigee at post-deploy: 190 x 166*
*These numbers are highly variable depending on real-time LDEF altitude at time of launch.

Vehicle and Payload Weights

	Pounds
Orbiter (Columbia) Empty	185,363
Remote Manipulator System (payload bay)	858
Syncom IV-5 (payload bay)	5,286
Syncom ASE	1801
Long Duration Exposure Facility (LDEF)	21,393
Interim Operational Contamination Monitor (IOCM))	137
American Flight Echocardiograph (AFE)	111
Characterization of Neurospora Circadian Rhythms (CNCR)	43
Detailed Secondary Objectives (DSO)	163
Detailed Technical Objectives (DTO)	36
Fluids Experiment Apparatus (FEA)	148
IMAX Camera	274
Latitude-Longitude Locator (L3)	56
Mesoscale Lightning Experiment (MLE)	15
Protein Crystal Growth Experiment (PCG)	154
Orbiter and Cargo at SRB Ignition	256,670
Total Vehicle at SRB Ignition	4,523,534
Orbiter Landing Weight	229,526

Summary of major activities

Day One
- Ascent
- Post-insertion checkout
- Unstow cabin
- RMS checkout
- AFE
- CNCR
- DSO
- FEA unstow
- PCG activation

Day Two
- Syncom IV deploy
- AFE
- DSO/DTO
- FEA
- IMAX

Day Three
- Syncom backup deploy/injection
- AFE
- DSO/DTO
- FEA
- IMAX

Day Four
- LDEF rendezvous
- LDEF grapple
- LDEF photo survey
- LDEF berthing
- LDEF deactivation
- AFE
- DTO
- FEA
- IMAX

Day Five
- AFE
- DSO
- FEA
- L3 setup
- IMAX

Day Six
- AFE
- DSO/DTO
- FEA
- IMAX

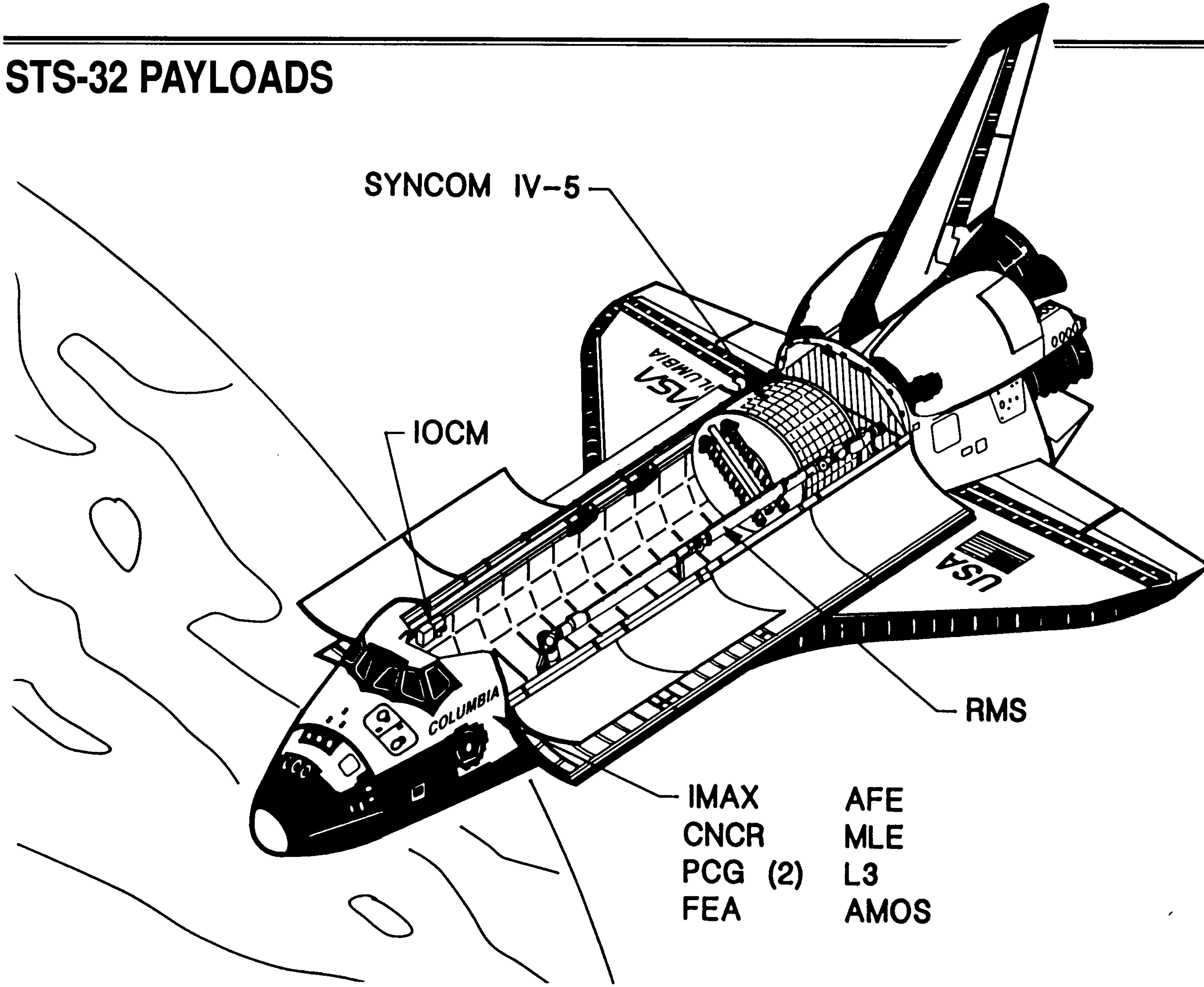
Day Seven
- AFE
- DSO/DTO
- FEA
- IMAX

Day Eight
- AFE
- DSO/DTO
- FEA stow
- IMAX

Day Nine
- AFE stow
- DSO/DTO
- FCS checkout
- IMAX stow
- L3 stow
- PCG deactivation
- Cabin stow
- Landing preparations

Day 10
- Deorbit preparations and burn
- Landing at Edwards AFB

STS-32 PAYLOADS



LANDING AND POST-LANDING OPERATIONS

The Kennedy Space Center is responsible for ground operations of the orbiter once it has rolled to a stop on the runway at Edwards Air Force Base. Those operations include preparing Columbia for the return trip to Kennedy.

After landing, the flight crew aboard Columbia begins "safing" vehicle systems. Immediately after wheels stop, specially garbed technicians will first determine that any residual hazardous vapors are below significant levels in order for other safing operations to proceed.

A mobile white room is moved into place around the crew hatch once it is verified that there are no concentrations of toxic gases around the forward part of the vehicle. The flight crew is expected to leave Columbia about 45 to 50 minutes after landing. As the crew exits, technicians will enter the orbiter to complete the vehicle safing activity.

Pending completion of planned work and favorable weather conditions, the 747 Shuttle Carrier Aircraft would depart California about 6 days after landing for the cross-country ferry flight back to Florida. Several refueling stops will be necessary to complete the journey because of the weight of the LDEF payload.

Once back at Kennedy, Columbia will be pulled inside the hangar like processing facility where the retrieved Long Duration Exposure Facility (LDEF) will be removed from the payload bay. Orbiter post-flight inspections, in-flight anomaly trouble-shooting and routine systems reverification will commence to prepare Columbia for its next mission.

STS-32 PAYLOADS

SYNCOM IV-F5

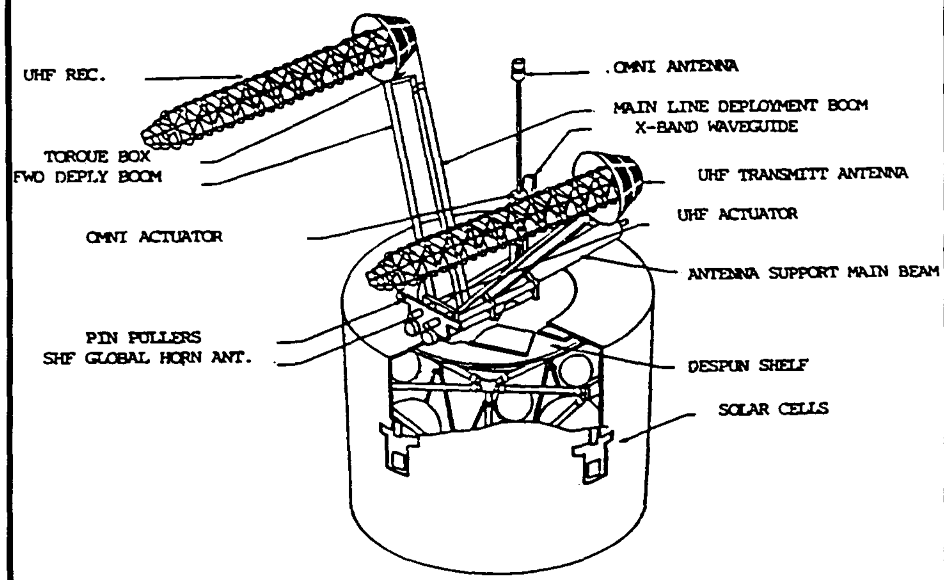
Syncom IV-F5, also known as LEASAT 5, will be the fourth operational satellite in the LEASAT system. It will be leased by the Department of Defense to replace the older FleetSatCom spacecraft for worldwide UHF communications between ships, planes and fixed facilities. A Hughes HS381 design, the LEASAT spacecraft is designed expressly for launch from the Space Shuttle and uses the unique "Frisbee," or rollout, method of deployment.

The first two spacecraft were deployed during the 1984 41-D and 51-A Shuttle missions. LEASAT 3 was deployed successfully in 1985 during mission 51-D but failed to activate. The satellite drifted in low-Earth orbit until a salvage and rescue mission was performed by the crew of mission 51-I in September 1985. Following a series of modifications by the Shuttle crew, LEASAT 3 was successfully deployed into its operational orbit. Also as part of mission 51-I, LEASAT 4 was successfully deployed from the orbiter. However, it did not go into operational service due to a spacecraft failure shortly after arrival at geosynchronous orbit.

Interface between the spacecraft and the payload bay is accomplished with a cradle structure. The cradle holds the spacecraft with its forward end toward the nose of the orbiter. Mounting the antennas on deployable structures allows them to be stowed for launch.

Five trunnions (four longeron and one keel) attach the cradle to the orbiter. Five similarly located internal attach points attach the spacecraft to the cradle.

SYNCOM IV-F5



OPERATIONAL CONFIGURATION

Another unique feature of the Syncom IV series of satellites is the lack of requirement for a separately purchased upper stage, as have all other communications satellites launched to date from the Shuttle.

The Syncom IV satellites contain their own unique upper stage to transfer them from the Shuttle deploy orbit of about 160 nm to a circular orbit 19,300 nm over the equator.

Each satellite is 20 feet long with UHF and omnidirectional antennas deployed. Total payload weight in the orbiter is 17,000 pounds. The satellite's weight on station, at the beginnng of its life, will be nearly 3,060 pounds. Hughes' Space and Communications Group builds the satellites.

Ejection of the spacecraft from the Shuttle is initiated when locking pins at the four contact points are retracted. An explosive device then releases a spring that ejects the spacecraft in a "Frisbee" motion. This gives the satellite its separation velocity and gyroscopic stability. The satellite separates from the Shuttle at a velocity of about 1.5 feet per second and a spin rate of about 2 rpm.

As part of this mission, Columbia must rendezvous with the Long Duration Exposure Facility (LDEF). As a result, the normal Syncom IV launch condition constraints were relaxed so that Columbia could launch at any time of day, any day of the year. This change resulted in modifications to the spacecraft to permit three different mission scenarios required to meet the spacecraft operational constraints for different launch windows.

The first mission scenario is the standard Syncom IV sequence controlled by the Post Ejection Sequencer (PES). In the PES mode, a series of maneuvers, performed over a period of several days, will be required to place Syncom IV into its geosynchronous orbit over the equator. The process starts 80 seconds after the spacecraft separates from Columbia with the automatic deployment of the omnidirectional antenna. Forty-five minutes after deployment, the solid perigee kick motor, identical to that used as the third stage of the Minuteman missile, is ignited, raising the high point of the satellite's orbit to approximately 8,200 nm.

Two liquid fuel engines that burn hypergolic propellants, monomethyl hydrazine and nitrogen tetroxide, are used to augment the velocity on successive perigee transits, to circularize the orbit and to align the flight path with the equator.

The first of three such maneuvers raises the apogee to 10,500 nm, the second to 13,800 nm and the third to geosynchronous orbital altitude. At this point, the satellite is in a transfer orbit with a 160 nm perigee and a 19,300 nm apogee. The final maneuver circularizes the orbit at the apogee altitude.

In the second mission scenario, called the Sub Transfer Earth Orbit or SEO Mode, the post-ejection sequencer fires the perigee kick motor 45 minutes after ejection from the cargo bay, as in the PES mode. However, in the SEO mode, the perigee augmentation maneuvers are delayed for up to 20 days to optimize spacecraft performance. After this delay, the mission is identical to the PES mission.

In the third mission scenario, called Low Earth Orbit or LEO mode, the post-ejection sequencer does not fire the perigee kick motor. Instead, the spacecraft is stored in low-Earth orbit for up to 15 days, until the PKM firing constraints are met. The perigee kick motor is then fired by ground command. The subsequent mission is identical to the PES mission.

The selection of the optimal mission scenario for Syncom IV-F5 will depend on the launch day and window selected for LDEF retrieval. This should be known several weeks before launch, but can be changed as late as 11 hours before launch.

Hughes Communications, Inc. operates the worldwide LEASAT satellite communications system under a contract with the Department of Defense, with the U.S. Navy acting as the executive agent. The system includes four LEASAT satellites and the associated ground facilities. Users include mobile air, surface, subsurface and fixed ground stations of the Navy, Marine Corps, Air Force and Army. The satellites are positioned for coverage of the continental United States and the Atlantic, Pacific and Indian oceans. LEASAT 1, 2 and 3 occupy geostationary positions at 15 degrees West, 73 degrees East and 105 degrees West, respectively. LEAST 5 will be positioned at 177 degrees W.

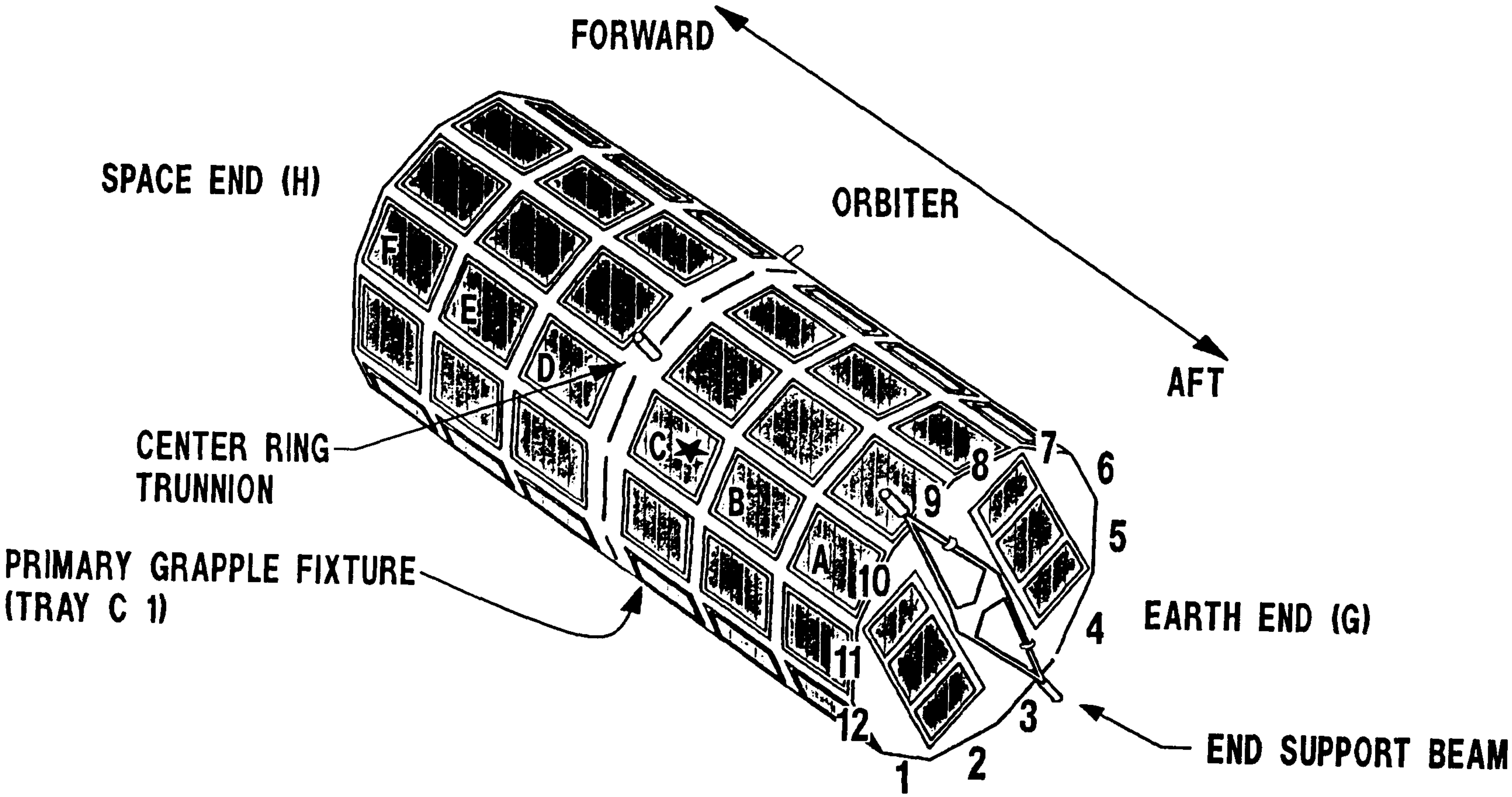
LONG DURATION EXPOSURE FACILITY RENDEZVOUS AND RETRIEVAL

LDEF was delivered to Earth orbit by STS-41C (STS-13) on April 6, 1984. The orbiter Columbia will rendezvous and retrieve LDEF using a -R BAR approach and the remote manipulator system (RMS) for berthing of the spacecraft in the payload bay on flight day four.

LDEF Rendezvous and Grapple

As the orbiter nears LDEF, the -R BAR approach will be initiated. The orbiter will first pass below the spacecraft and circle up and over it. The -R BAR approach is a new technique that does not require close-in fly-around. This maneuver will

LONG DURATION EXPOSURE FACILITY



★ Secondary grapple fixture containing Experiment Initiate System (tray C 10) face the payload bay toward Earth and LDEF will now be between, as well as perpendicular, to both the Earth and the orbiter.

At this point, Columbia is approximately 400 feet from LDEF with the RMS arm extended and the wrist camera pointing toward the orbiter's starboard side. The wrist camera will provide the primary field of view for grapple. A yaw maneuver then will be performed to place the wrist camera in the same x,y plane as grapple fixture 2 (GF2) aboard LDEF, so that the camera can eventually view GF2 head on.

LDEF is then directly "above" the crew compartment (the arm is still in its same position; unattached to the LDEF). This allows Commander Dan Brandenstein and Pilot Jim Wetherbee to make necessary flight instrument changes to "fly in formation" with the same speed and direction as the free-flying LDEF.

Next, the orbiter will move forward (+ZLV) very slowly. The crew will be watching their onboard monitor for the LDEF to appear in the wrist camera's field of view. As soon as GF2 is spotted, orbiter movement will cease. The wrist camera then will rotate 180 degrees to be properly positioned for the grapple of GF2.

Mission specialist Bonnie Dunbar then will direct the RMS toward GF2 and make the connection for grapple completion. LDEF will be approximately 35 feet above the bay during this procedure.

LDEF Berthing

The onboard computer then commands the arm to align LDEF with the berthing guides on the payload bay sides. The final RMS maneuvering now will be commanded manually to set LDEF in the bay (if there are no failures, this process should take approximately 15 minutes).

The crew also will utilize the black and white camera positioned at keel station 3 aiming it at a docking target. The crew will be watching the on-board monitor with an overlay for precision berthing. Three orange styrofoam balls called "berthing whiskers" will extend horizontally inward from the forward payload bay side walls. The berthing whiskers will act as "curb feelers" to detect forward movement of LDEF.

LDEF Post-Berthing

The arm will now detach from GF2 and move to GF1, looking for the six Experiment Initiator System (EIS) indicators. If the EIS's are black, the experiments power supply is already off. If they are white, the arm will move into GF1 and turn off the experiments. Finally, the arm will be stowed.

LDEF POST-FLIGHT

STS-32 is a unique mission for payloads operations, as specialists must perform not only "up-processing" (i.e. pre-flight operations to prepare the Syncom IV payload for integration into the orbiter) but also a "down-processing" for 57 experiments that have been exposed to the harsh space environment for more than 5 years aboard the Long Duration Exposure Facility.

In supporting the return of LDEF, the KSC payload team, working closely with Langley Research Center, has planned a post-flight flow that accentuates the preservation of the scientific data. In addition, special research teams from Langley, which sponsored the project, will be at KSC when LDEF returns.

LDEF will remain in Columbia's payload bay during routine post-flight servicing at Edwards Air Force Base, Calif. and during the ferry-flight back to KSC.

To assist in maintaining experiment integrity, an air-conditioned purge system will be hooked up to the orbiter during its stay at EAFB and any overnight stops. This system will keep air-conditioned air circulating through the payload bay.

Once Columbia is in the Orbiter Processing Facility (OPF), LDEF will be removed from the cargo bay and placed in a payload canister and transported to the Operations and Checkout Building (O&C). There, LDEF will be loaded from the canister to the LATS (LDEF Assembly and Transportation System). This special "cradle" is 55 feet long, 17 feet wide, and 21 feet high. LATS also was used during the pre-launch processing of LDEF.

LDEF is expected to be in the O&C from about Jan. 8-12. Then, supported by the LATS, it will be transferred to the Spacecraft Assembly and Encapsulation Facility, where the experiments will be taken off the frame and turned over to researchers.

Post-Mission Operations

At KSC, LDEF will be turned over to Langley personnel for off-line facility and experiment operations.

Before any experiment activities or operations begin, there will be an initial inspection of LDEF and its experiments to check the general condition of the spacecraft and to look for any unexpected changes.

Once the initial inspection is completed, all of the principal investigators (PI) and the Special Investigation Groups (SIG) will conduct detailed visual inspections of the entire LDEF and all of the visible experiment hardware.

Experiment trays will be removed from the LDEF and taken on ground support equipment transporters to an experiment operations area. After batteries are removed from once-active experiments, trays will go to a work bench where the PIs will perform closer inspections and take basic measurements. After the PIs have completed their procedures, the experiment hardware will be properly configured, packaged and shipped to the PIs' laboratories.

An accessible LDEF database will be developed to document all of the information resulting from the LDEF mission. It is anticipated that this unique body of data on space experiments and the effects of long-term exposure in space on typical spacecraft hardware will become a valued resource to future spacecraft designers. Structures like the LDEF provide a relatively inexpensive way to conduct experiments and may be reusable. Requirements for the use of the LDEF or similar facilities for follow-on flights will be evaluated at a later date.

Structure

LDEF is a 12-sided, open grid structure made of aluminum rings and longerons (fore-and-aft framing members). The structure is 30 feet long, 14 feet in diameter and weighs 8,000 pounds.

LDEF's center ring frame and end frames are of welded and bolted construction. The longerons are bolted to both frames, and intercostals (crosspieces between longerons) are bolted to the longerons to form intermediate rings. The main load of LDEF was transmitted to the orbiter through two side-support trunnions on the center ring.

LDEF holds 86 experiment trays, 72 around the circumference, six on the Earth-pointing end and eight on the space-pointing end. A typical tray measures 50 inches by 34 inches and investigators could choose one of three depths: 3, 6 or 12 inches. The trays are made of aluminum and hold experiments that weigh up to 200 pounds. Some experiments fill more than one tray; some fill only part of a tray. All trays and their experiments weigh only 13,400 pounds. Total weight of the structure, trays and experiments is 21,393 pounds.

Experiments

The LDEF experiments are divided into four groups: materials and structures, power and propulsion, science and electronics and optics. The 57 experiments on LDEF involve 200 investigators, who represent 21 universities, 33 private companies, seven NASA centers, nine Department of Defense laboratories and eight foreign countries.

LDEF science experiments include an interstellar gas experiment that may provide insight into the formation of the Milky Way galaxy by capturing and analyzing its interstellar gas atoms.

LDEF cosmic radiation experiments are designed to investigate the evolution of the heavier elements in our galaxy.

LDEF micrometeoroid experiments could increase understanding of the processes involved in the evolution of our Solar System. The impact of space radiation on living organisms is another area investigated. LDEF science experiments gathered data on the radiation intensity and its effect on living organisms such as shrimp eggs and plant seeds.

Other LDEF experiments collected data on the behavior of a multitude of materials used to manufacture spacecraft and space experiment systems exposed to space, including radiation, vacuum, extreme temperature variations, atomic oxygen and collision with space matter. The LDEF mission has provided important information for the design of future spacecraft that will require extended lifetimes in space, such as Space Station Freedom.

Several LDEF experiments were designed to investigate the effects of prolonged exposure to the space environment on optical system components, which include optical filters, coatings, glasses, detectors and optical fiber transmission links. LDEF provided an opportunity to study the effects of long-term space exposure on the design of solar array power systems by investigating the effects of exposure to the space environment on a wide variety of solar cells and associated components.

A unique process for growing crystals in solutions, which took advantage of the microgravity conditions provided by LDEF, was used to grow high purity crystals with unique electrical properties applicable to electronic circuits.

The Space Exposed Experiment Developed for Students (SEEDS) offers a wide variety of opportunities for student experiments. Investigators will provide a total of 12.5 million tomato seeds, packaged in kits, to students from the upper elementary through the university level. Students will have the unprecedented opportunity to study the effects of long-term space exposure on tomato seeds. The program encourages active student involvement and a multidisciplinary approach, allowing students to design their own experiments and to be involved in decision making, data gathering and reporting of final results.

The low cost of an LDEF experiment encouraged high-risk/high-return investigations and made experiments particularly attractive to students and research groups with no experience in space experimentation. Investigators could take advantage of NASA and private industry expertise to develop relatively inexpensive investigations.

The LDEF structure was designed and built at the Langley Research Center in Hampton, Va. Experiment trays were provided to investigators, who built their own experiments, installed them in trays and tested them. To help reduce costs, each investigator established the amount of reliability, quality control and testing required to insure proper operation of his experiment.

The LDEF project is managed by Langley for NASA's Office of Aeronautics and Space Technology in Washington, D.C. E. Burton Lightner is Manager of the LDEF Project Office. William H. Kinard is LDEF Chief Scientist and Head of the Data Analysis Team.

AMERICAN FLIGHT ECHOCARDIOGRAPH

The American Flight Echocardiograph is an off-the-shelf medical ultrasonic imaging system modified for Space Shuttle compatibility. The AFE noninvasively generates a two-dimensional, cross-sectional image of the heart or other soft tissues and displays it on a cathode-ray tube (CRT) at 30 frames per second.

AFE has flown before on STS-51D and is designed to provide inflight measurements of the size and functioning of the heart and record heart volume and cardiovascular responses to space flight. Results from the AFE will be used in the development of optimal countermeasures to crew cardiovascular changes.

Operated by STS-32 Mission Specialist Marsha Ivins, the AFE hardware will be stored in an orbiter middeck locker. All five crew members will participate in the experiment as subjects as time allows. Crew members also will use the AFE to support Detailed Secondary Objective 478, the first flight of a collapsible Lower Body Negative Pressure unit.

In echocardiography, a probe next to the skin sends high frequency sound waves (ultrasound) through the skin and into the body, then detects reflections or echos from the surfaces of the organs, producing pictures.

The Life Sciences Division of NASA's Office of Space Science and Applications is sponsoring the AFE which was developed at the Johnson Space Center. Dr. Michael Bungo, the Director of JSC's Space Biomedical Research Institute, is the Principal Investigator.

CHARACTERIZATION OF NEUROSPORA CIRCADIAN RHYTHMS

Characterization of Neurospora Circadian Rhythms (CNCR) in Space is a middeck payload sponsored by the Office of Space Science and Applications, Life Sciences Division. The objective of the CNCR experiment is to determine if neurospora (pink bread mold) circadian rhythm (diurnal cycles) persists in the microgravity environment of space.

This experiment is intended to provide information about endogenously driven biological clocks, which might then be applied to other organisms. Endogenous indicates the activity occurs within a single cell's outer membrane.

Neurospora grows in two forms, a smooth confluence of silky threads (mycelia) and cottony tufts of upright stalks tipped with tiny ball-shaped spores (conidia). When growing in a constant, completely uniform external environment, the neurospora mold cycles rhythmically from one growth form to the other. This cycle causes the mold to produce the ball-shaped spores on approximately 21-hour intervals. This interval is believed to be controlled by an internal cell clock.

However, under typical circumstances, alterations in the external environment, particularly day-night cycles with a period of 24 hours, are capable of readjusting the neurospora internal clock. The fundamental question addressed by this Shuttle experiment is whether the conditions of space flight, especially the absence of Earth's strong gravitational field, affect the neurospora's circadian rhythms. Because these rhythmic phenomena also are found in all plants and animals, including humans, this experiment addresses a broad and important biological question.

The Principal Investigator is Dr. James S. Ferraro, Southern Illinois University, Carbondale, Ill. Project Manager is Dr. Randall Berthold at NASA's Ames Research Center, Mountain View, Calif. Project Scientist is Dr. Charles Winget, also at Ames. Program Scientist/Manager is Dr. Thora Halstead, NASA Headquarters Life Sciences Division. Mission Manager is Willie Beckham of NASA's Johnson Space Center, Houston.

PROTEIN CRYSTAL GROWTH EXPERIMENT

The Protein Crystal Growth (PCG) payload aboard STS-32 is a continuing series of experiments that may prove a major benefit to medical technology. These experiments could improve food production and lead to innovative new drugs to combat cancer, AIDS, high blood pressure, organ transplant rejection, rheumatoid arthritis and many other diseases.

Protein crystals, like inorganic crystals such as snowflakes, are structured in a regular pattern. With a good crystal, roughly the size of a grain of table salt, scientists are able to study the protein's molecular architecture.

Determining a protein crystal's molecular shape is an essential step in several phases of medical research. Once the three-dimensional structure of a protein is known, it may be possible to design drugs that will either block or enhance the protein's normal function within the body. Though crystallographic techniques can be used to determine a protein's structure, this powerful technique has been limited by problems encountered in obtaining high-quality crystals well-ordered and large enough to yield precise structural information.

Protein crystals grown on Earth are often small and flawed. The problem associated with growing these crystals is analogous to filling a sports stadium with fans who all have reserved seats. Once the gate opens, people flock to their seats and in the confusion, often sit in someone else's place. On Earth, gravity-driven convection keeps the molecules crowded around the "seats" as they attempt to order themselves. Unfortunately, protein molecules are not as particular as many of the smaller molecules and are often content to take the wrong places in the structure.

As would happen if you let the fans into the stands slowly, microgravity allows the scientist to slow the rate at which molecules arrive at their seats. Since the molecules have more time to find their spot, fewer mistakes are made, creating better and larger crystals.

During the STS-32 mission, 120 different PCG experiments will be conducted simultaneously using as many as 24 different proteins. Though there are three processes used to grow crystals on Earth—vapor diffusion, liquid diffusion and dialysis— only vapor diffusion will be used in this set of experiments.

Shortly after achieving orbit, either Mission Specialist Marsha Ivins or Mission Specialist David Low will combine each of the protein solutions with other solutions containing a precipitation agent to form small droplets on the ends of double-barreled syringes positioned in small chambers. Water vapor will diffuse from each droplet to a solution absorbed in a porous reservoir that lines each chamber. The loss of water by this vapor diffusion process will produce conditions in the droplets that cause protein crystals to grow.

In three of the 20-chambered, 15-by-10-by-1.5-inch trays, crystals will be grown at room temperature (22 degrees Centigrade); the other three trays will be refrigerated (4 degrees C) during crystal growth. STS-32 will be the first mission during which PCG experiments will be run at 4 degrees C, making it possible to crystalize a wider selection of proteins. The 9-day flight also provides a longer time period for crystals to grow.

A seventh tray will be flown without temperature control. The crew will videotape droplets in the tray to study the effects of orbiter maneuvers and crew activity on droplet stability and crystal formation.

Just prior to descent, the mission specialist will photograph the droplets in the room temperature trays. Then all the droplets and any protein crystals grown will be drawn back into the syringes. The syringes then will be resealed for reentry. Upon landing, the hardware will be turned over to the investigating team for analysis.

Protein crystal growth experiments were first carried out by the investigating team during Spacelab 2 in April 1985. These experiments have flown six times. The first four flights were primarily designed to develop space crystal growing techniques and hardware.

The STS-26 and STS-29 experiments were the first scientific attempts to grow useful crystals by vapor diffusion in microgravity. The main differences between the STS-26 and STS-29 payloads and those on previous flights were the introduction of temperature control and the automation of some of the processes to improve accuracy and reduce the crew time required.

To further develop the scientific and technological foundation for protein crystal growth in space, NASA's Office of Commercial Programs and the Microgravity Science and Applications Division are co-sponsoring the STS-32 experiments with management provided through Marshall Space Flight Center, Huntsville, Ala. Blair Herren is the Marshall experiment manager and Richard E. Valentine is the mission manager for the PCG experiment at Marshall.

Dr. Charles E. Bugg, director of the Center for Macromolecular Crystallography, a NASA-sponsored Center for the Development of Space located at the University of Alabama-Birmingham, is lead investigator for the PCG research team.

The STS-32 industry, university and government PCG research investigators include CNRS, Marseille, France; Eli Lilly & Co.; U.S. Naval Research Laboratory; E.I. du Pont de Nemours & Co.; Merck Sharp & Dohme Laboratories; Texas A&M University; University of Alabama-Birmingham/Schering Corp.; Yale University; University of Pennsylvania; University of California at Riverside; The Weizmann Institute of Science; Marshall Space Flight Center; Australian National University/BioCryst, Ltd.; University of Alabama-Birmingham/BiCryst; Smith Kline & French Labs.; The Upjohn Co.; Eastman Kodak Co.; Wellcome Research Labs. and Georgia Institute of Technology.

MICROGRAVITY RESEARCH WITH THE FLUIDS EXPERIMENT APPARATUS

Fluids Experiment Apparatus

The Fluids Experiment Apparatus (FEA) is designed to perform materials processing research in the microgravity environment of spaceflight. Its design and operational characteristics are based on actual industrial requirements and have been coordinated with industrial scientists, NASA materials processing specialists and Space Shuttle operations personnel. The FEA offers experimenters convenient, low-cost access to space for basic and applied research in a variety of product and process technologies.

The FEA is a modular microgravity chemistry and physics laboratory for use on the Shuttle and supports materials processing research in crystal growth, general liquid chemistry, fluid physics and thermodynamics. It has the functional capability to heat, cool, mix, stir or centrifuge gaseous, liquid or solid experiment samples. Samples may be processed in a variety of containers or in a semicontainerless floating zone mode. Multiple samples can be installed, removed or exchanged through a 14.1-by-10-inch door in the FEA's cover.

Instrumentation can measure sample temperature, pressure, viscosity, etc. A camcorder or super-8mm movie camera may be used to record sample behavior. Experiment data can be displayed and recorded through the use of a portable computer that also is capable of controlling experiments.

The interior of the FEA is approximately 18.6-by-14.5-by-7.4 inches and can accommodate about 40 pounds of experiment-unique hardware and subsystems. The FEA mounts in place of a standard stowage locker in the middeck of the Shuttle crew compartment, where FEA is operated by the flight crew.

Modular design permits the FEA to be easily configured for almost any experiment. Configurations may be changed in orbit, permitting experiments of different types to be performed on a single Shuttle mission. Optional subsystems may include custom furnace and oven designs, special sample containers, low-temperature air heaters, specimen centrifuge, special instrumentation and other systems specified by the user. Up to 100 watts of 120-volt, 400-Hertz power is available from the Shuttle orbiter for FEA experiments. The FEA was successfully flown on two previous missions, as a student experiment on STS-41D and as the first flight of the JEA on STS-30.

Rockwell International, through its Space Transportation Systems Division, Downey, Calif., is engaged in a joint endeavor agreement (JEA) with NASA's Office Commercial Programs in the field of floating zone crystal growth and purification research. The 1989 agreement provides for microgravity experiments to be performed on two Space Shuttle missions.

Under the sponsorship of NASA's Office of Commercial Programs, the FEA will fly aboard Columbia on STS-32. Rockwell is responsible for developing the FEA hardware and for integrating the experiment payload. Johnson Space Center, Houston, has responsibility for developing the materials science experiments and for analyzing their results.

The Indium Corporation of America, Utica, N.Y., is collaborating with NASA on the experiments and is providing seven indium samples to be processed during this mission. NASA provides standard Shuttle flight services under the JEA.

Floating Zone Crystal Growth and Purification

The floating zone process is one of many techniques used to grow single crystal materials. The process involves an annular heater that melts a length of sample material and then moves along the sample. As the heater moves (translates), more of the polycrystalline material in front of it melts. The molten material behind the heater will cool and solidify into a single crystal.

The presence of a "seed" crystal at the initial solidification interface will establish the crystallographic lattice structure and orientation of the single crystal that results. Impurities in the polycrystalline material will tend to stay in the melt as it passes along the sample and will be deposited at the end when the heater is turned off and the melt finally solidifies.

Under the influence of Earth's gravity, the length of the melt is dependent upon the density and surface tension of the material being processed. Many industrially important materials cannot be successfully processed on Earth because of their properties. In the microgravity environment of spaceflight, there is a maximum theoretical molten zone length which can be achieved.

Materials of industrial interest include selenium, cadmium telluride, gallium arsenide and others. Potential applications for those materials include advanced electronic electro-optical devices and high-purity feed stock. Zone refining to produce ultra-high purity indium also is of interest for the production of advanced electronic devices from indium antimonide and indium arsenide.

FEA-3 Experiment Plan

The FEA-3 microgravity disturbances experiment involves seven samples (plus one spare) of commercial purity indium (99.97 percent purity). Indium was chosen for this experiment because it is a well-characterized material and has a relatively low melting point (156 degrees Celsius). The samples each will be 1 centimeter in diameter and 18 centimeters long and will be processed in an inert argon atmosphere. The sample seeding heater translation rates and process durations are provided in the following table:

Experiment Samples and Parameters

Sample	Seeded	Heater Rate (cm/hour)	Duration (hours)
1	No	0	2.00
2	Yes	24	4.50
3	Yes	12	9.00
4	Yes	24	4.50
5	Yes	48	2.25
6	Yes	12	9.00
7	Yes	96	1.10

At 5.25 hours mission elapsed time (MET), the flight crew will unstow the FEA and connect its computer and support equipment. The samples will be sequentially installed at 20, 26, 44, 66, 97, 114 and 144 hours MET and processed.

The experiment parameters (heater power and translation rate) will be controlled by the operator through the FEA control panel. Sample behavior (primarily melt-zone length and zone stability) will be observed by the operator and recorded using the on-board camcorder. Experiment data (heater power, translation rate and position, experiment time, and various experiment and FEA temperatures) will be formatted, displayed to the operator and recorded by the computer. The operator will record the MET at the start of each experiment and significant orbiter maneuvers and other disturbances that occur during FEA operations. In addition, accelerometer measurements during the induced disturbances will be recorded for postflight analysis.

In general, the experiment process involves installing a sample in the FEA, positioning the heater at a designated point along the sample, turning on the heater to melt a length of the sample, starting the heater translation at a fixed rate and maintaining a constant melt-zone length. When the heater reaches the end of the sample, it is turned off, allowing the sample to completely solidify, and the heater's translation is reversed until it reaches the starting end of the sample. The sample 8mm camcorder cassette and computer disk with the experiment data then can be changed and the next experiment started.

FEA-3 Experiment Description

Most materials are processed in space to take advantage of the low gravity levels achievable in low-Earth orbit, which has been demonstrated to produce superior quality crystals over those grown on the ground. The focus of the FEA-3 experiment entitled "Microgravity Disturbances Experiment," is to investigate the effects of both orbiter and crew-induced disturbances in the microgravity environment on the resulting microstructure of float-zone-grown indium crystals.

The FEA-3 experiment is one of the first designed specifically to grow crystals during known disturbances to investigate their effects on crystal growth processes. The disturbances to be investigated in this experiment will focus on orbiter engine firings and crew exercise on the treadmill, but will include several other disturbances typical of orbiter operations. This research should provide information useful in establishing the microgravity-level requirements for processing materials aboard Space Station Freedom and also provide a greater understanding of the role of residual gravity in materials processing.

This experiment will also investigate the effects of disturbances on the stability of a freely suspended molten zone and provide information on the impurity refining capability of float zone processing in space.

MESOSCALE LIGHTNING EXPERIMENT

Space Shuttle mission STS-32 will again carry the Mesoscale Lightning Experiment (MLE), designed to obtain nighttime images of lightning to better understand the global distribution of lightning, the relationships between lightning events in nearby storms and relationships between lightning, convective storms and precipitation.

A better understanding of the relationships between lightning and thunderstorm characteristics can lead to the development of applications in severe storm warning and forecasting and in early warning systems for lightning threats to life and property.

In recent years, NASA has used the Space Shuttle and high-altitude U-2 aircraft to observe lightning from above convective storms. The objectives of these observations have been to determine some of the baseline design requirements for a satellite-borne optical lightning mapper sensor; study the overall optical and electrical characteristics of lightning as viewed from above the cloud top and to investigate the relationship between storm electrical development and the structure, dynamics and evolution of thunderstorms and thunderstorm systems.

The MLE began as an experiment to demonstrate that meaningful, qualitative observations of lightning could be made from the Shuttle. Having accomplished this, the experiment is now focusing on quantitative measurements of lightning characteristics and observation simulations for future space-borne lightning sensors.

Data from the MLE will provide information for the development of observation simulations for an upcoming polar platform and Space Station instrument, the Lightning Imaging Sensor. The lightning experiment also will be helpful for designing procedures for using the Lightning Mapper Sensor, planned for several geostationary platforms.

The Experiment

The Space Shuttle payload bay camera will be pointed directly below the orbiter to observe nighttime lightning in large, or mesoscale, storm systems to gather global estimates of lightning as observed from Shuttle altitudes. Scientists on the ground will analyze the imagery for the frequency of lightning flashes in active storm clouds within the camera's field of view, the length of lightning discharges and cloud brightness when illuminated by the lightning discharge within the cloud.

If time permits during missions, astronauts also will use a handheld 35mm camera to photograph lightning activity in storm systems not directly below the Shuttle's orbital track.

Data from the MLE will be associated with ongoing observations of lightning made at several locations on the ground, including observations made at facilities at the Marshall Space Flight Center, Huntsville, Ala.; Kennedy Space Center, Fla.; and the NOAA Severe Storms Laboratory, Norman, Okla. Other ground-based lightning detection systems in Australia, South America and Africa will be integrated when possible.

The MLE is managed by NASA's Marshall Space Flight Center. Otha H. Vaughan Jr., is coordinating the experiment. Dr. Hugh Christian is the project scientist and Dr. James Arnold is the project manager.

IMAX

The IMAX project is a collaboration between NASA and the Smithsonian Institution's National Air and Space Museum to document significant space activities using the IMAX film medium. This system, developed by the IMAX Systems Corp., Toronto, Canada, uses specially designed 70mm film cameras and projectors to record and display very high definition large-screen color motion pictures.

IMAX cameras previously have flown on Space Shuttle missions 41-C, 41-D and 41-G to document crew operations in the payload bay and the orbiter's middeck and flight deck along with spectacular views of Earth. Film from those missions form the basis for the IMAX production, *The Dream is Alive.*

In 1985, during Shuttle Mission STS-61-B, an IMAX camera mounted in the payload bay recorded extravehicular activities in the EASE/ACCESS space construction demonstrations.

So far in 1989, the IMAX camera has flown twice, during Shuttle missions STS-29 in March and STS-34 in October. During those missions, the camera was used to gather material for an upcoming IMAX production entitled *The Blue Planet.*

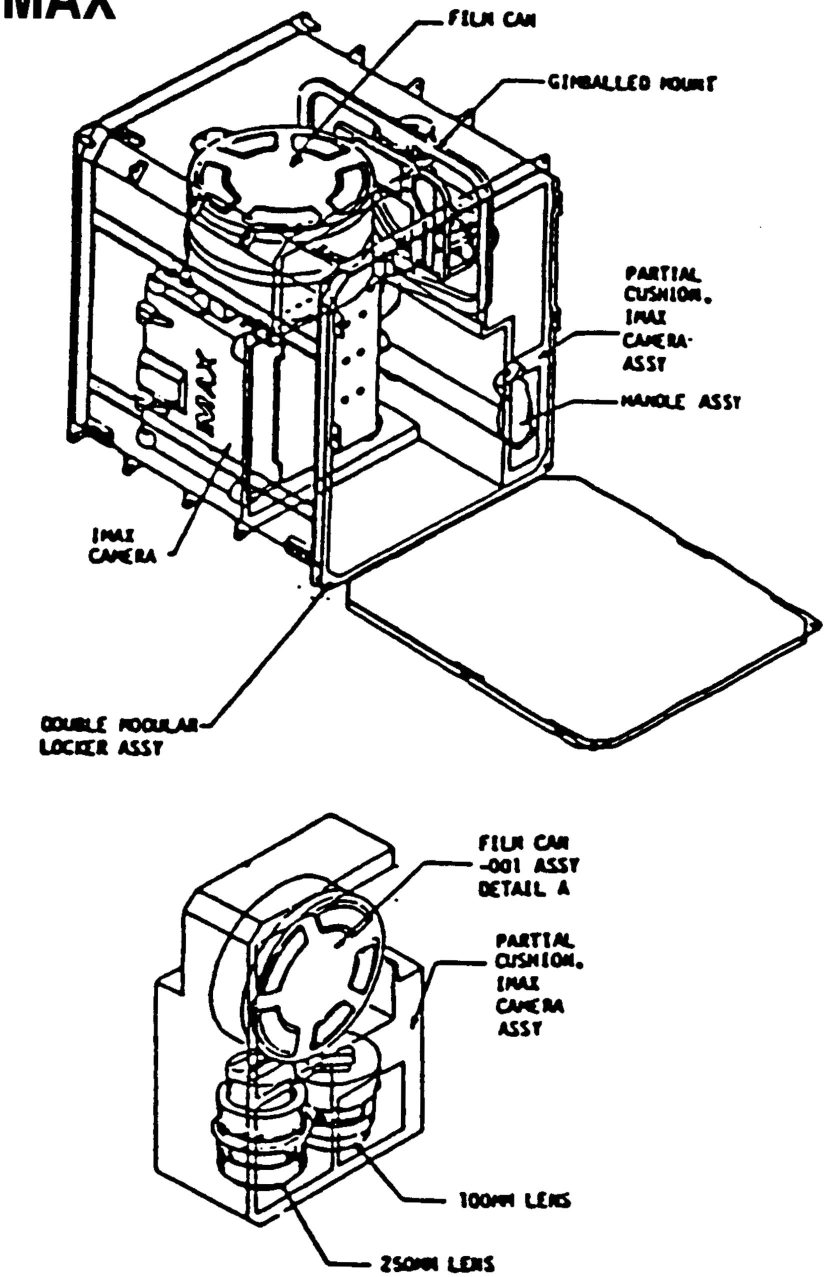
During STS-32, IMAX will film the retrieval of the Long Duration Exposure Facility and collect additional material for upcoming IMAX productions.

AIR FORCE MAUI OPTICAL SITE CALIBRATION TEST (AMOS)

The Air Force Maui Optical Site (AMOS) tests allow ground-based electro-optical sensors located on Mount Haleakala, Maui, Hawaii, to collect imagery and signature data of the orbiter during overflights of that location. The scientific observations made of the orbiter while performing reaction control system thruster firings, water dumps or payload bay light activation, are used to support calibration of the AMOS sensors and the validation of spacecraft contamination models. The AMOS tests have no payload-unique flight hardware and only require that the orbiter be in a pre-defined attitude operations and lighting conditions.

The AMOS facility was developed by the Air Force Systems Command (AFSC) through its Rome Air Development Center,

IMAX



Griffiss Air Force Base, N.Y., and is administered and operated by the AVCO Everett Research Laboratory in Maui. The principal investigator for the AMOS tests on the Space Shuttle is from AFSC's Air Force Geophysics Laboratory, Hanscom Air Force Base, Mass. A co-principal investigator is from AVCO.

Flight planning and mission support activities for the AMOS test opportunities are provided by a detachment of AFSC's Space Systems Division at Johnson Space Center. Flight operations are conducted at JSC Mission Control Center in coordination with the AMOS facilities located in Hawaii.

LATITUDE-LONGITUDE LOCATOR EXPERIMENT

On Shuttle mission 41-G, Payload Specialist and oceanographer Scully Power observed numerous unusual oceanographic features from orbit but was unable to determine their exact locations for subsequent study. NASA, in conjunction with the Department of Defense, began work on an instrument that would be able to determine the precise latitude and longitude of objects observed from space.

The Latitude-Longitude Locator (L3) was developed and flown on a previous Space Shuttle mission. This flight will continue tests to determine the accuracy and usability of the system in finding the latitude and longitude of known ground sites.

L3 consists of a modified Hasselblad camera equipped with a wide-angle 40 mm lens, a camera computer interface developed by JSC engineers and a Graphics Retrieval and Information Display (GRID) 1139 Compass Computer.

Crew members will take two photographs of the same target at an interval of approximately 15 seconds. Information will be fed to the GRID computer, which will compute two possible locations. The crew, by knowing whether the target is north or south of the flight path, will be able to determine which of the two locations is correct and the target's latitude and longitude.

Andy Saulietis of NASA's Johnson Space Center is the Principle Investigator for the experiment.

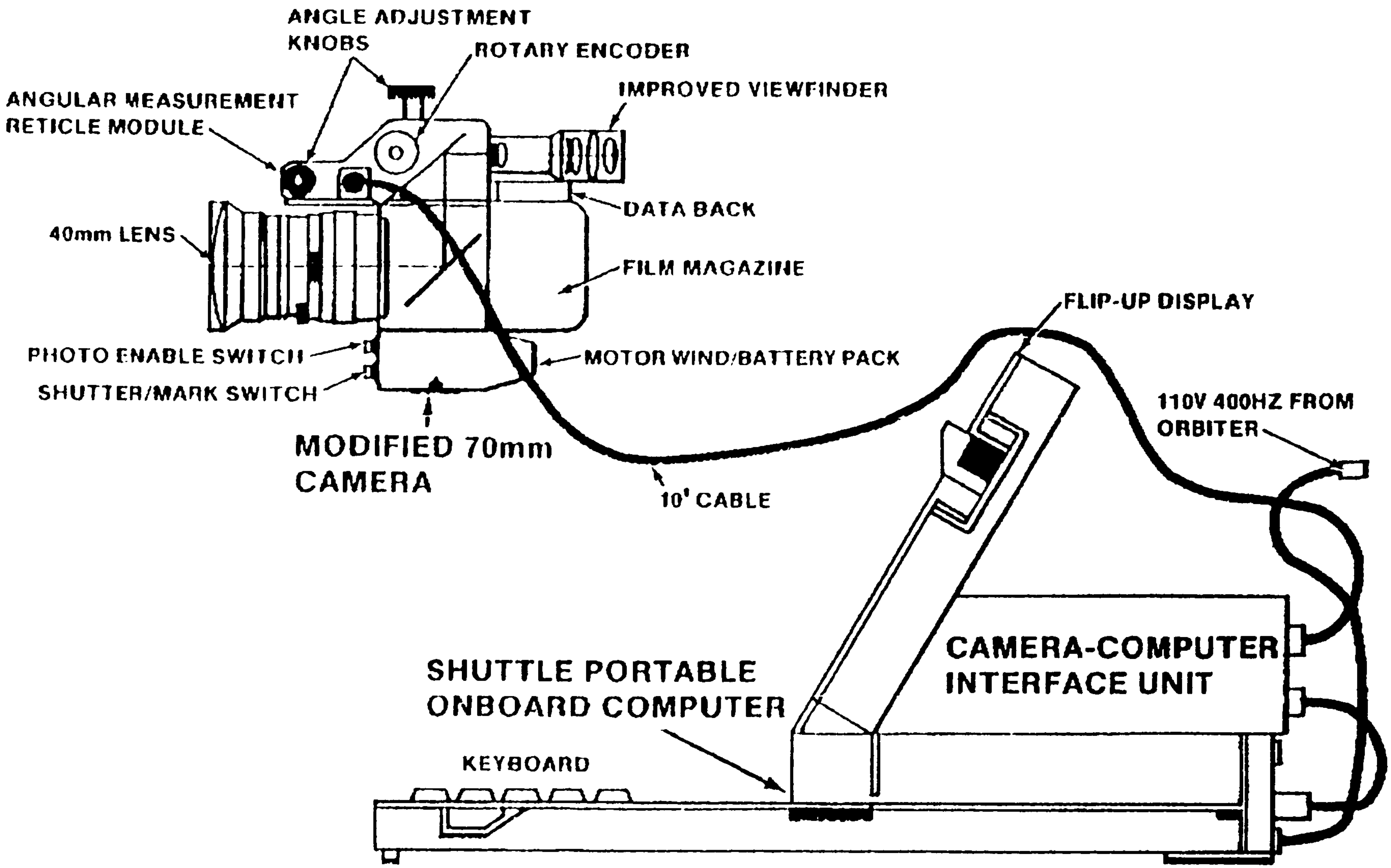
SPACEFLIGHT TRACKING AND DATA NETWORK

Primary communications for most activities on STS-32 will be conducted through the orbiting Tracking and Data Relay Satellite System (TDRSS), a constellation of three communications satellites, two operational and one spare, in geosynchronous orbit 22,300 miles above the Earth. In addition, three NASA Spaceflight Tracking and Data Network (STDN) ground stations and the NASA Communications Network (NASCOM), both managed by Goddard Space Flight Center, Greenbelt, Md., will play key roles in the mission.

Three stations—Merritt Island and Ponce de Leon, Fla., and Bermuda—serve as the primary communications facilities during the launch and ascent phases of the mission. For the first 80 seconds, all voice, telemetry and other communications from the Space Shuttle are relayed to the mission managers at Kennedy and Johnson Space Centers by Merritt Island.

At 80 seconds, the communications are picked up from the Shuttle and relayed to the two NASA centers from Ponce de

LATITUDE-LONGITUDE LOCATOR CONFIGURATION



Leon, 30 miles north of the launch pad. This facility provides the communications between the Shuttle and the centers for 70 seconds, or until 150 seconds into the mission. This is during a critical period when exhaust from the solid rocket motors "blocks out" the Merritt Island antennas.

Merritt Island resumes communications with the Shuttle after those 70 seconds and maintains communications until 6:30 after launch, when communications are "switched over" to Bermuda. Bermuda then provides the communications until 11 minutes after lift off when the TDRS-East satellite acquires the Shuttle. TDRS-West acquires the orbiter at launch plus 50 minutes.

Communications will alternate between the TDRS-East and TRDS-West satellites as the Shuttle orbits the Earth. The two satellites will provide communications with the Shuttle during 85 percent or more of each orbit. The TDRS-West satellite will handle communication with the Shuttle during its descent and landing phases.

CREW BIOGRAPHIES

Daniel C. Brandenstein, 46, Capt. USN, will serve as commander. Selected as an astronaut in January 1978, he was born in Watertown, Wisc., and will be making his third Shuttle flight.

Brandenstein was pilot for STS-8, the third flight of Challenger, launched on Aug. 30, 1983. During the 6-day mission, the five-member crew deployed the Indian National Satellite (INSAT-1B) and tested the orbiter's remote manipulator system (RMS) with the Payload Test Article.

On his second flight, Brandenstein served as commander for STS-51G, launched June 17, 1985. During the 7-day mission, the 18th Space Shuttle flight, the seven-member crew deployed the Morelos satellite for Mexico; the Arabsat satellite for the Arab League; and the AT&T Telstar satellite. Also, the RMS was used to deploy and later retrieve the SPARTAN satellite.

Following STS-51G, Brandenstein became deputy director of flight crew operations at JSC and later assumed his current post, chief of the Astronaut Office.

He graduated from Watertown High School in 1961 and received a B.S. degree in mathematics and physics from the University of Wisconsin in 1965. Brandenstein was designated a naval aviator in 1967. During the Vietnam War and later as a test pilot, he logged more than 5,200 hours of flying time in 24 types of aircraft and has more than 400 carrier landings.

James D. Wetherbee, 37, Lt. Cmdr., USN, will serve as pilot. Selected as an astronaut in May 1984, he was born in Flushing, N.Y., and will be making his first Shuttle flight.

Wetherbee graduated from Holy Family Diocesan High School, South Huntington, N.Y., in 1970 and received a B.S. in aerospace engineering from Notre Dame in 1974.

Wetherbee was designated a naval aviator in December 1976. After serving aboard the aircraft carrier USS John F. Kennedy, he attended the Naval Test Pilot School and completed training there in 1981. He then worked with testing of, and later flew, the F/A-18 aircraft until his selection by NASA.

Wetherbee has logged more than 2,500 hours flying in 20 types of aircraft and completed more than 345 carrier landings.

Bonnie J. Dunbar, 40, will serve as mission specialist 1 (MS1). Selected as an astronaut in August 1981, she was born in Sunnyside, Wash., and will be making her second Shuttle flight.

Dunbar served as a mission specialist on STS-61A, the West German D-1 Spacelab mission and the first Shuttle flight to carry eight crew members. During the 7-day mission, Dunbar was responsible for operating the Spacelab and its subsystems as well as performing a variety of experiments.

Dunbar graduated from Sunnyside High School in 1967; received a B.S. degree and an M.S. degree in ceramic engineering from the University of Washington in 1971 and 1975, respectively; and received a doctorate in biomedical engineering from the University of Houston in 1983.

Dunbar joined NASA as a payload officer/flight controller at JSC in 1978. She served as a guidance and navigation officer/flight controller for the Skylab reentry mission in 1979, among other tasks, prior to her selection as an astronaut. She is a private pilot with more than 200 hours in single-engine aircraft and more than 700 hours in T-38 jets as a co-pilot.

Marsha S. Ivins, 38, will serve as mission specialist 2 (MS2). Selected as an astronaut in May 1984, she was born in Baltimore, Md., and will be making her first Shuttle flight.

Ivins graduated from Nether Providence High School, Wallingford, Pa., in 1969 and received a B.S. degree in aerospace engineering from the University of Colorado in 1973.

She began her career with NASA as an engineer in the Crew Station Design Branch at JSC in July 1974. Her work involved Space Shuttle displays and controls and development of the orbiter head-up display. In 1980, Ivins became a flight simulation engineer on the Shuttle Training Aircraft and also served as a co-pilot on the NASA administrative aircraft, a Gulfstream I.

Ivins has logged more than 4,500 hours flying time in NASA and private aircraft and holds a multi-engine airline transport pilot license with a Gulfstream I rating; single-engine airplane, land, sea and commercial licenses; a commercial glider license; and instrument, multi-engine and glider flight instructor ratings.

G. David Low, 33, will serve as mission specialist 3 (MS3). Selected as an astronaut in May 1984, he was born in Cleveland and will be making his first Shuttle flight.

Low graduated from Langley High School, McLean, Va., in 1974; received a B.S. degree in physics-engineering from Washington and Lee University in 1978; received a B.S. degree in mechanical engineering from Cornell University in 1980; and received a M.S. degree in aeronautics and astronautics from Stanford University in 1983.

Low began his career with NASA in 1980 in the Spacecraft Systems Engineering Section of the NASA Jet Propulsion Laboratory (JPL), Pasadena, Calif., where he participated in the preliminary planning of several planetary missions and the systems engineering design of the Galileo spacecraft. Following a 1-year leave of absence from JPL to pursue graduate studies, he returned and worked as the principal spacecraft systems engineer for the Mars Geoscience/Climatology Observer Project until his selection as an astronaut.

As an astronaut, his technical assignments have included work with the RMS and extravehicular systems. He also served as a spacecraft communicator during STS-26, STS-27 and STS-29.

NASA PROGRAM MANAGEMENT

NASA HEADQUARTERS
Washington, D.C.

Richard H. Truly
NASA Administrator

James R. Thompson Jr.
NASA Deputy Administrator

William B. Lenoir
Associate Administrator
for Space Flight

George W.S. Abbey
Deputy Associate Administrator
for Space Flight

Robert L. Crippen
Acting Director, Space Shuttle Program
Deputy Director, Space Shuttle Operations

Leonard S. Nicholson
Deputy Director, Space Shuttle Program
(located at Johnson Space Center)

David L. Winterhalter
Director, Systems Engineering
and Analyses

Gary E. Krier
Director, Operations Utilization

Joseph B. Mahon
Deputy Associate Administrator
for Space Flight (Flight Systems)

Charles R. Gunn
Director, Unmanned Launch Vehicles
and Upper Stages

George A. Rodney
Associate Administrator for Safety,
Reliability,
Maintainability and Quality Assurance

Arnold Aldrich
Associate Administrator for
Office of Aeronautics and Space
Technology

Lana Couch
Director for Space

Jack Levine
Director, Flight Projects Division

John Loria
LDEF Program Manager

Sam Venneri
Director, Materials and Structures Division

James T. Rose
Assistant Administrator for Commercial
Programs

Charles T. Force
Associate Administrator for Operations

Dr. Lennard A. Fisk
Associate Administrator for Space Science
and Applications

A. V. Diaz
Deputy Associate Administrator for
Space Science and Applications

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Houston, Texas

Aaron Cohen
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Deputy Director

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Acting Manager, Orbiter and GFE Projects

Donald R. Puddy
Director, Flight Crew Operations

Eugene F. Kranz
Director, Mission Operations

Henry O. Pohl
Director, Engineering

Charles S. Harlan
Director, Safety, Reliability and Quality
Assurance

Kennedy Space Center
Merritt Island, Fla.

Forrest S. McCartney
Director

Thomas E. Utsman
Deputy Director

Jay F. Honeycutt
Director, Shuttle Management
and Operations

Robert B. Sieck
Launch Director

George T. Sasseen
Shuttle Engineering Director

Larry Ellis (Acting)
Columbia Flow Director

James A. Thomas
Director, Safety, Reliability and
Quality Assurance

John T. Conway
Director, Payload Management
and Operations

Marshall Space Flight Center
Huntsville, Ala.

Thomas J. Lee
Director

Dr. J. Wayne Littles
Deputy Director

G. Porter Bridwell
Manager, Shuttle Projects Office
Ac ting Manager, External Tank Project

Dr. George F. McDonough
Director, Science and Engineering

Alexander A. McCool
Director, Safety, Reliability and Quality Assurance

Royce E. Mitchell
Manager, Solid Rocket Motor Project

Cary H. Rutland
Manager, Solid Rocket Booster Project

Jerry W. Smelser
Manager, Space Shuttle Main Engine Project

Langley Research Center: Hampton, Va.

Richard H. Petersen
Director

Frank Allario
Director for Electronics

Leon Taylor
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E. Burton Lightner
LDEF Project Manager

William H. Kinard
LDEF Chief Scientist

Charles Blankenship
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Stennis Space Center Bay St. Louis, Miss.

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Gerald W. Smith
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Ames Research Center Mountain View, Calif.

Dr. Dale L. Compton
Acting Director

Ames-Dryden Flight Research Facility Edwards, Calif.

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Theodore G. Ayers
Deputy Site Manager

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Chief, Research Aircraft Operations Division

Larry C. Barnett
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Goddard Space Flight Center Greenbelt, Md.

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Director, Mission Operations and Data Systems

Daniel A. Spintman
Chief, Networks Division

Wesley J. Bodin
Associate Chief, Ground Network

Gary A. Morse
Network Director

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202-453-8400

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For Release:
December 1, 1989

RELEASE: 89-181

NASA SELECTS SMALL BUSINESS INNOVATION RESEARCH PROJECTS

NASA today announced selection of 84 research proposals for negotiation of Phase II contract awards in their Small Business Innovation Research (SBIR) program. Included are 77 small, high technology firms located in 24 states.

Selections were chosen competitively from 185 proposals submitted for Phase II continuations of SBIR Phase I projects initiated in 1988. Total value of awards is about $41 million.

SBIR objectives are to stimulate technological innovation, to increase small business participation, including minority and disadvantaged firms, in federal research and development programs, and to foster growth and economic strength of the private sector.

SBIR Phase II continues the most promising Phase I projects, those which have demonstrated feasibility and potential value to NASA as research innovations. Selection criteria includes technical merit and innovation, Phase I results, value to NASA and commercial potential, and company capabilities.

Funding for Phase II contracts may be up to $500,000 for up to a 2-year period.

Additional Phase II selections, to be made in early 1990, are expected to bring the total number of selections to more than 100 and the total procurement value to more than $50 million.

SBIR projects are procured and managed by nine NASA field centers. NASA's Office of Commercial Programs, NASA Headquarters, Washington, D.C., provides overall program management.

- end -

Editor's Note: A listing of the selected companies and their locations is available in the NASA Headquarters newsroom and all NASA field center newsrooms.

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202-453-8400

For Release:

December 11, 1989
1 p.m. EST

Mary Sandy
Headquarters, Washington, D.C.
(Phone: 202/453-2754)

Del Harding
Ames Research Center, Mountain View, Calif.
(Phone: 415/694-5091)

RELEASE: 89-182

COMPTON NAMED AMES RESEARCH CENTER DIRECTOR

NASA Administrator Richard H. Truly today named Dale L. Compton as Director of the NASA Ames Research Center, Moffett Field, Calif. Compton's appointment becomes effective on December 20, the 50th anniversary of the center's groundbreaking.

Compton, who succeeds Dr. William F. Ballhaus, has been Acting Director since Ballhaus' resignation on July 15.

Compton previously served as Acting Director for the Center from February 1988 to January 1989. He served as Deputy Director of Ames with line management responsibility for the center's facilities, personnel and programs from 1985 to 1988 and from January through July 15, 1989.

As Director, Compton will be responsible for all research and development programs and the overall management of the Ames Research Center at Moffett Field and the Ames-Dryden Flight Research Facility at Edwards Air Force Base, Calif. Ames-Moffett and Ames-Dryden, which have more than 5,000 employees, conduct research and development programs in the fields of aeronautics, life science, space science, space technology and flight research.

Compton's professional career has been spent with NASA Ames where he served as a research scientist for 15 years and published over 25 papers on aerodynamic and aerothermodynamic subjects. He also has served as Deputy Director, Astronautics; Chief, Space Science Division; Manager, IRAS Telescope Project office; and Director, Engineering and Computer Systems at the Center.

-more-

Compton was educated at Stanford University where he received a B.S. degree in 1957, an M.S. in 1958 and a Ph.D. in aeronautical engineering in 1969. He was a Sloan Fellow at the Massachusetts Institute of Technology from 1974 to 1975 and attended the Harvard Advanced Management Program in 1986. He has received the NASA Outstanding Leadership Medal and is a Fellow of the American Institute of Aeronautics and Astronautics.

Compton and his wife, Marilyn, have two children. They reside in Cupertino, Calif.

-end-

NASA News

National Aeronautics and
Space Administration

Washington, D.C. 20546
AC 202-453-8400

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David W. Garrett
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For Release:
December 22, 1989

RELEASE: 89-183

THE YEAR IN REVIEW - 1989

Major events in the nation's space program included the following:

o A new "golden era" of space science got underway as NASA sent the Magellan spacecraft to map Venus, Galileo to orbit Jupiter and drop a probe into its atmosphere and the Cosmic Background Explorer to study the origin of the universe and look for its "missing matter." Voyager II paid a spectacular visit to the planet Neptune 2.8 billion miles from Earth. By the time the 5-year "golden era" concludes, NASA will have launched 37 major science missions that may radically alter mankind's view of the universe.

o President Bush announced on July 20, the twentieth anniversary of the Moon landing, that it would be a goal of the United States to establish a permanent human presence on the Moon and use the experience gained there to begin human exploration of the planet Mars.

o Richard H. Truly became NASA's eighth administrator on July 1. The day before, he retired from the Navy as a Vice Admiral, having served more than 30 years. A former astronaut, he headed NASA's Office of Space Flight for almost 3-1/2 years.

o NASA launched five successful Space Shuttle missions, deploying - in addition to the Magellan and Galileo science missions - a Tracking and Data Relay Satellite to complete the TDRS network.

o Truly consolidated the Space Flight and Space Station Freedom offices and announced plans to merge the offices of Exploration and Aeronautics and Space Technology. In both cases the goal is close coordination of programs. Final Space Station agreements were signed by the United States and its international partners.

- more -

SPACE SCIENCE AND APPLICATIONS

SOLAR SYSTEM

Planetary science spearheaded accomplishments in 1989 with Voyager 2's exploration of Planet Neptune and departure from the solar system and the launch of two probes that began "a new Golden Age of Space Science," in the words of Dr. Lennard A. Fisk, NASA's Associate Administrator for Space Science and Applications.

Voyager 2's close-up view of Neptune showed a bright blue planet with winds of 1,500 mph and six previously unknown moons. Triton posed several new challenges for planetary geologists, the most interesting being how the coldest known body in the solar system could be one of the most geologically active, with four ice volcanoes.

Months before Voyager's main mission ended, the second phase of planetary exploration had begun. In May, the Space Shuttle deployed the Magellan spacecraft, which will map the surface of Venus. In October, Galileo began its roundabout trip to Jupiter, where it will drop a probe into the Jovian atmosphere in the first direct study of the solar system's largest planet.

Closer to home, NASA scientists discovered last spring that on March 23 an asteroid a half-mile or more in diameter passed within 500,000 miles of Earth, about twice the distance between the Earth the Moon. "On the cosmic scale of things, that was a close call," said Dr. Henry Holt of the University of Arizona, who discovered the asteroid while working on a NASA-funded project for the U.S. Geological Survey.

In the fall, scientists at the Arecibo Observatory in Puerto Rico used the radio telescope there to map another asteroid that passed within 2.5 million miles of the Earth. Images showed a two-lobed body a mile long spinning like a propeller every four hours.

ASTROPHYSICS

In November, NASA launched the Cosmic Background Explorer, an unmanned observer that will measure the cosmic radiation remaining from the "Big Bang" in hopes of developing a clearer picture of the early history of the universe.

Astronomers at the Space Telescope Science Institute, following research sponsored by NASA, reported unanticipated gas emissions from a "white dwarf" star. White dwarves had been thought to mark the end of some stars' lifespans, precluding such emissions. At the end of the year, NASA and science institute scientists were continuing preparations for the Shuttle deployment in March 1990 of the Hubble Space Telescope, which many astronomers believe will open a new era for the field.

EARTH SCIENCES

In February, NASA announced the selection of scientific instrument investigations for the proposed Earth Observing System, a multi-purpose platform for launch in late 1997. EOS would be an interdisciplinary program conducted with the European and Japanese space agencies using four platforms in polar orbits to examine Earth on a global scale.

EOS would be one of the largest science missions ever undertaken, providing 15 years of comprehensive data on Earth's atmosphere, oceans and land. EOS is part of the Mission to Planet Earth concept discussed by President Bush in July. Mission to Planet Earth would be a major interagency effort to understand the complex interactions of our environment, to assess humanity's role in shaping them and to build credible models capable of predicting future change.

This year a NASA satellite gathered further evidence of humans' effect on their environment as the Total Ozone Mapping Spectrometer showed the ozone levels over Antarctica between August and October were as low in 1989 as the record low levels measured in 1987. Earlier aircraft campaigns had already shown that the ozone hole over Antarctica was due to human activities, specifically the release of chlorine compounds.

Scientists from the Soviet Union, Canada, the United Kingdom and France joined NASA in Kansas over the summer to continue the first field experiment for the International Satellite Land Surface Climatology Project. The experiment investigated the role of biological processes in controlling atmosphere-vegetation interactions and investigated the use of satellite and airborne observations to infer how land-surface conditions affect climate.

SPACE PHYSICS

NASA signed a memorandum of understanding with the European Space Agency to conduct a series of missions as part of the International Solar Terrestrial Physics Programme, which will track solar energy from its source, through space and as it reaches and passes the Earth. A similar agreement for a Japanese-U.S. mission is in the final stages of negotation.

NASA launched four suborbital rockets over Canada to measure Earth's electric fields aligned with its magnetic field and possibly explain how aurora are created. The rockets released barium payloads, creating greenish-purple clouds over parts of Canada and the north-central United States.

NASA has provided a payload instrument (PEGSAT) for flight aboard the experimental air-launched vehicle Pegasus now undergoing flight tests with an anticipated launch date of late January 1990. The instrument will conduct studies of the Earth's magnetic field and ionosphere.

LIFE SCIENCES

U.S. and Soviet scientists confirmed the adverse physiological and biomedical effects of prolonged space flight after analyzing data from the cooperative life sciences experiments flown aboard an unmanned Soviet satellite. The United States has invited Soviet scientists to participate in the analysis of life science experiments to be flown aboard the June 1990 Spacelab mission.

NASA scientists identified the molecular structure of blood protein using special X-ray techniques. Their discovery may help in the design of new or improved disease-fighting drugs.

SPACE FLIGHT

In 1989, 25 astronauts orbited the Earth aboard Space Shuttles Discovery, Atlantis and Columbia. As a result, sophisticated interplanetary spacecraft, Magellan and Galileo, are speeding toward orbital encounters with Venus and Jupiter, a new Tracking and Data Relay Satellite had been deployed and experiment data have been sent to investigators nationwide.

With the exception of a handful of small-class Scouts, the stable of NASA-owned expendable launch vehicles (ELVs) was emptied in 1989 with the successful launches of the Atlas-Centaur/FLTSATCOM and Delta/Cosmic Background Explorer missions. Procurement of future medium- and intermediate-class launch services from the private sector accelerated during the year as NASA/industry launch teams looked forward to a new way of doing ELV business.

Among Space Flight highlights, 1989 are:

- January 20: Sixth and final full-scale static test firing of NASA's redesigned Space Shuttle solid rocket motor took place successfully.

- March 2: NASA's Marshall Space Flight Center selected Aerojet General Corp., Rockwell International and United Technology Corp. to develop efforts for demonstrating mature new propulsion technologies for the Nation's Advanced Launch System.

- March 13: Space Shuttle Discovery was launched with STS-29 Astronauts Coats, Blaha, Buchli, Springer and Bagian on board to deploy a new Tracking and Data Relay Satellite. Landing was March 18.

- April 21: NASA selected Lockheed Missile Systems Division and its principal subcontractor, Aerojet Space Booster Company, for final negotiations leading to award of a contract to design, develop, test and evaluate a Space Shuttle advanced solid rocket motor (ASRM) and a contract for construction of facilities for production and testing of the ASRM hardware.

- May 4: Space Shuttle Atlantis was launched with STS-30 Astronauts Walker, Grabe, Thagard, Cleave and Lee on board to deploy the Magellan spacecraft on a mission toward Venus. Landing was May 8.

- June 19: NASA held the first of two Commercial Launch Services Symposia to better understand specific industry concerns about the agency's launch services procurement practices. A follow-up symposium was held in August during which NASA responded to industry concerns expressed in June.

- June 30: NASA selected Boeing Co. and Martin Marietta Corp. for negotiations leading to award of contracts to study future Space Transfer Vehicle concepts.

- July 18: NASA selected McDonnell Douglas Space Systems Co. for negotiations leading to award of a contract for up to 15 medium-class expendable launch vehicle services.

- August 8: Space Shuttle Columbia was launched with STS-28 Astronauts Shaw, Richards, Leetsma, Adamson and Brown on board this dedicated DoD mission. Landing was August 13.

- September 25: NASA successfully launched its final Atlas/Centaur launch vehicle from Cape Canaveral Air Force Station. The payload was a FLTSATCOM Navy communications satellite.

- October 18: Space Shuttle Atlantis was launched with STS-34 Astronauts Williams, McCulley, Baker, Chang-Diaz and Lucid on board to deploy Galileo spacecraft on a mission toward Jupiter. Landing was October 23.

- November 16: Proposals were received by NASA from two industry teams for the performance of definition studies for a new vehicle -- the Assured Crew Return Vehicle -- to serve as a lifeboat for Space Station Freedom astronauts.

- November 18: NASA successfully launched its Cosmic Background Explorer spacecraft from Vandenberg Air Force Base, Calif., aboard the final NASA-owned Delta launch vehicle.

- November 22: Space Shuttle Discovery was launched with STS-33 Astronauts Gregory, Griggs, Musgrave, Thornton and Carter on board this dedicated DOD mission. Landing was November 27.

SPACE STATION FREEDOM

Major changes in the the organization and management of the Space Station Freedom program occurred 1989. In additional to being named Associate Administrator for Space Station, Dr. William B. Lenoir developed and implemented a plan consolidating the Space Station and Space Flight offices.

A major review of the Space Station Freedom project, brought on by the changes in the management of the multi-national project and under threat of a significant budget cut for Fiscal Year 1990, resulted in modifications to the project and a revised timetable for its development and deployment.

Under direction from the NASA Administrator, newly appointed Space Station Freedom Project Director Richard H. Kohrs led the program through a major technical, budget and schedule evaluation, resulting in changes to the station's baseline configuration and assembly schedule.

The scheduled date for the first launch of an element of Freedom was held to March 1995. Subsequent milestones for achieving a man-tended configuration and a permanent manned capability were adjusted 5 and 7 months, to April 1996 and July 1997, respectively, and assembly completion was delayed 18 months to August 1999.

System modifications made as a result of the review included changing from a hydrogen/oxygen propulsion system to a modular hydrazine system and switching from a hybrid ac/dc system to an all-dc system for distributing electrical power throughout Freedom. Development of high-pressure space suits for extravehicular activities was put off indefinitely in favor of using current, Shuttle-based suits for assembly and maintenance of Freedom. Various subsystems, such as the closed-loop environmental control system, data management and communications and tracking, will be incrementally brought to their full capability as the station is being assembled.

The final agreement between NASA and its international partners, which together are developing Freedom, was signed March 14 as the former NASA Administrator James Fletcher and Japanese ambassador to the U.S. H. E. Nobuo Matsunaga signed a memorandum of understanding on cooperation in the detailed design, development, operation and utilization of the space station. Similar agreements with the European Space Agency and Canada were signed in September 1988. Japan will provide the Japanese Experiment Module to the Freedom program.

In April, NASA's Goddard Space Flight Center, Greenbelt, Md., selected Martin Marietta Space Systems Co., Denver, to build the Flight Telerobotic Servicer, a space station-based robot to aid in the assembly and maintenance of Freedom.

EXPLORATION

On July 20, 1989 President Bush announced a national commitment to an evolutionary program to complete Space Station Freedom, establish a manned lunar outpost, begin the exploration of Mars and eventually to move beyond.

The work of the NASA Office of Exploration over the past 2 years laid the foundation for that decision. In 1989, the office also initiated a variety of activities to better understand technology needs and science opportunities involved in expanding the human presence beyond Earth orbit. The office continued to develop multiple options for human exploration through the case study framework.

Three case studies were evaluated in 1989: Lunar Evolution, Mars Evolution and Mars Expedition. These case studies refined NASA's understanding and broadened its knowledge of human exploration options, the investments required to support them and the scientific and technological capabilities and benefits they would spawn.

Other key developments in 1989 included:

- Formation of a NASA Advisory Council Exploration Task Force to provide independent advice to NASA and the Office of Exploration. The Task Force is chaired by Robert McC. Adams, Secretary of the Smithsonian Institution, Washington, D.C.

- Support of and participation in preparation of NASA's "Report of the 90-Day Study on Human Exploration of the Moon and Mars". The report was commissioned by NASA Administrator Richard H. Truly to help the National Space Council develop recommendations to President Bush on ways to achieve his exploration goals.

- Initiation of an Innovative Studies Program designed to encourage innovative concepts and support independent studies that may offer unique capabilities for human exploration. The program encompassed three areas in 1989: an "Innovative Outreach" program designed to solicit original and creative ideas from traditional and non-traditional sources; a lunar enterprise study to provide a non-NASA perspective on commercial uses of the Moon; and a study designed to define a potential operational lunar mining system. More than 100 proposals were submitted under the "Innovative Outreach" program.

The 20 proposals selected for funding came from groups located in 12 states and included five industry-related firms, two space support-related organizations and 13 universities. The subject matter of the selected studies ranges from nuclear thermal rockets using Martian propellants to pneumatic structures for lunar and Martian habitats.

AERONAUTICS AND SPACE TECHNOLOGY

Aeronautics

The National Aero-Space Plane (NASP) program, a joint NASA/Department of Defense program, continued technology development that could lead to a unique flight research vehicle, called the X-30, capable of taking off horizontally, accelerate into Earth orbit and returning through the atmosphere to land on a conventional runway.

NASA's Lewis Research Center, Cleveland is leading an effort to develop "slush" hydrogen as a high-energy NASP propellant. It is denser than liquid hydrogen and may result in smaller, lighter fuel tanks that could reduce the X-30's takeoff weight by up to 30 percent.

Lewis also tested a Mach 5 (five times the speed of sound) engine inlet to verify computer codes used in analysis of the inlet's performance. This research will apply to the NASP program and other future high-speed aircraft.

Langley Research Center, Hampton, Va., has wind-tunnel tested the performance characteristics of NASP advanced engine concepts at 4 and 8 times the speed of sound. Scientists at Ames Research Center, Mountain View, Calif., have used wind tunnel tests and computational methods to research questions on high-temperature materials for structures and structure coatings.

NASA's high-performance aircraft based at Ames-Dryden Flight Research Facility, Edwards, Calif., made important contributions to the agency's aeronautics research program. The F/A-18 High-Alpha Research Vehicle completed the first phase of a three-part program to validate computer codes and wind tunnel predictions of airflow during high angle-of-attack flight. Results from this program will yield a better understanding of airflow phenomena at various flight angles, which should lead to improved maneuverability in future high-performance aircraft.

The first experimental forward-swept-wing X-29 aircraft wrapped up a highly successful test program after 242 flights that demonstrated its unique wing configuration is practical. The second X-29, modified to fly safely at angles-of-attack up to 70 degrees, also made its first research flight. As part of the NASA/DOD Self-Repairing Flight Control Program, computers aboard Ames-Dryden's F-15 research aircraft correctly identified and isolated a simulated failure in the flight control system.

NASA also continued efforts to enhance the efficiency of commercial air travel. The Propfan Test Assessment aircraft, a Gulfstream II business jet modified with an eight-bladed advanced turboprop engine on its left wing, wrapped up flight tests at Lewis Research Center.

The program was the end result of a major NASA-industry-university effort to develop the aerodynamic, structural, mechanical and acoustical technologies needed to verify the performance of such unique, fuel-efficient propellers.

At NASA's Langley Research Center, scientists and engineers conducted a series of high-speed ground tests to study the effect of heavy rain on the performance of aircraft wings. A full-scale commercial airfoil section mounted atop a tubular steel carriage made repeated runs through a curtain of simulated "rain" at typical takeoff and landing speeds. Initial results tend to confirm wind tunnel data that there is a loss of wing lift at extremely high rainfall rates.

Langley officials also announced development of an innovative new tool to help pilots make the critical go/abort decision during the takeoff roll. The Takeoff Performance Monitoring System provides continual "real-time" updates on an aircraft's performance, graphically presenting its progress relative to a normal takeoff for that type of airplane under the existing flight conditions.

Recognizing that U.S. leadership in the production and sale of commercial airliners is being challenged, NASA greatly expanded its research into advanced "composite" structures made from epoxy-type resins and high-strength carbon fiber. Use of such materials in the wings and fuselages of future transport aircraft could significantly reduce their weight, improve their fuel efficiency and reliability.

Space Technology

The Civil Space Technology Initiative addresses near-Earth orbital requirements in areas such as automation and robotics, space power and information technology. Space systems of the next decade will use these technologies for cost-effective and reliable operations in Earth orbit. The Pathfinder program focuses on technology research for future solar system voyages in four broad areas: surface exploration, in-space operations, transfer vehicles and humans in space.

In May, NASA's Ames Research Center, Mountain View, Calif., successfully demonstrated a low-cost, parallel-processing computer that potentially rivals today's most advanced supercomputers. The research program, a joint effort by NASA and the Defense Advanced Research Projects Agency, may allow applications such as structural analysis, artificial intelligence and computational electro-mechanics to run on smaller, more easily-affordable computers.

Scientists at Lewis reached a milestone in the application of high-temperature superconductors in July, when they produced the first electronic circuit able to operate at 33-37 Gigahertz -- three times higher than frequencies previously obtainable.

The circuit was fabricated from yttrium barium copper oxide, a material recently found to become superconductive at 77 degrees Kelvin. The use of these ultra-high frequencies will allow satellites to process data at much faster rates, tripling the number of communications linkups they can handle.

Voyager 2's encounter with Neptune gave researchers at the Jet Propulsion Laboratory, Pasadena, Calif., an opportunity to demonstrate a new "artificial intelligence" computer program to detect and analyze spacecraft and ground data system anomalies. The Spacecraft Health Automated Reasoning Prototype helped to identify a problem in the science data streaming down from Voyager prior to its Neptune fly-by.

During the encounter, the prototype detected three telecommunications errors simultaneously with human operators. The demonstration may lead to future expert systems that will increase the efficiency of mission operations and reduce the work force needed during planetary encounters.

NASA is preparing Shuttle Mission 32 to retrieve the Long Duration Exposure Facility that has carried 57 science, technology and applications experiments in Earth orbit since April 1984. Scientists expect the facility, managed by Langley Research Center, to provide a "treasure trove" of data about the effects of long-term exposure to space on components and materials -- invaluable knowledge in designing future spacecraft.

SPACE OPERATIONS

The Tracking and Data Relay Satellite (TDRS-4) was successfully deployed in March from the Shuttle Discovery, marking completion of the TDRS system. In June the system was declared operational following completion of a switchover involving TDRS 1, which was moved to 79 degress west longitude, to serve as backup to TDRS-4 and TDRS-3, also known as TDRS-East and TDRS-west, respectively.

The TDRS system covers at least 85 percent of each low-Earth-orbiting spacecraft's orbital period and facilitates a much higher information flow rate between these spacecraft and the ground.

The system will support up to 23 user spacecraft simultaneosly and provide both multiple-access service relaying data from as many as 19 low-data-rate user spacecraft at the same time and a single-access service that provides two high-data-rate communications relays from each satellite.

NASA concluded an agreement with INTELSAT, Washington, D.C., for the use of the C-Band capacity on two Tracking and Data Relay Satellites for international telecommunications purposes.

SAFETY, RELIABILITY, MAINTAINABILITY AND QUALITY ASSURANCE

NASA's Lewis Research Center (LeRC), Cleveland, was selected by the Office of Management and Budget (OMB) as a quality improvement prototype, which is one of the highest honors a federal government facility can achieve for quality and productivity. The award is part of the Presidents' Productivity Improvement program. The program is administered by OMB and is the second year the national award was presented.

The Lockeed Engineering and Sciences Co. (LESC), Houston, one of eight finalists selected in May, was named recipient of the NASA 1988-89 Excellence Award for Quality and Productivity. LESC was selected by the NASA Quality and Productivity Steering Committee and endorsed by the Administrator based on review of the findings report and recommendations of the Excellence Award Evaluation Committee.

To encourage more small businesses to improve their quality and productivity processes, NASA established a separate small business category for the 1989-90 Excellence Award Program. Key goals of the NASA Excellence Award are to institutionlize quality and productivity practices throughout NASA and the agency's contractors.

The Aerospace Safety Advisory Panel (ASAP) released its annual report in March praising NASA for its work on return-to-flight. The main focus of the ASAP was monitoring and advising NASA and its contractors on the STS recovery program. The report stated that efforts restored the flight program with better management, safety and quality assurance orgranizations and management communications.

INTERNATIONAL AFFAIRS

NASA's international cooperative activities in 1989 included:

o In October 1989, the Galileo spacecraft to Jupiter was successfully launched. Galileo is an international cooperative project with the Federal Republic of Germany, which provided the orbiter's retropropulsion module to perform mission maneuvers and permit insertion of the spacecraft into Jovian orbit. There are two German scientific experiments on Galileo as well and German scientists are participating in five other experiments.

o NASA signed a memorandum of understanding with the government of Japan in March, completing the international agreements for the construction and use of Space Station Freedom. Under the agreement, Japan will provide the Japanese Experiment Module consisting of a pressurized laboratory and an exposed facility. The European Space Agency and Canada had signed agreements for their participation in the project in September 1988.

o In July, NASA and the German Minister for Research and Technology signed a memorandum of understanding to launch German Spacelab payloads on the Space Shuttle. This agreement confirms general understandings of the terms and conditions with which NASA will furnish launch and associated services for both reimbursable flights and cooperative activities.

0 In September, the U.S. government and the government of Japan exchanged diplomatic notes approving cooperation on the Geotail Mission. Geotail is a Japanese-built spacecraft which will make solar-terrestrial physics measurements using Japanese and U.S. science instruments. NASA will launch the spacecraft in 1992.

o In December, NASA and the European Space Agency concluded an agreement for cooperation in the joint Solar Terrestrial Science Programme. This program consists of two missions, the Solar Heliospheric Observatory (SOHO) and Cluster (four spacecraft that will fly in formation to observe the Earth's plasma environment). Under this agreement, ESA will develop the spacecraft for SOHO and Cluster. NASA will launch and operate SOHO and ESA will launch and operate Cluster. Experiments on the spacecraft will be provided by the U.S. and European scientists.

o Cooperation with the Soviet Union continued to progress under the U.S./USSR Joint Working Groups on Space Biology and Medicine; Solar System Exploration; Space Astronomy and Astrophysics; Solar-Terrestrial Physics and Earth Sciences. Key activities included:

--A telemedicine spacebridge for Armenia, linking U.S. and Soviet hospitals, permitted medical consultation to assist with the longer-term consequences of the Armenian earthquake and injuries from the train explosion in Ufa. Comsat and Intelsat provided satellite transponders free of charge. Discussions continue on how the experience gained can be applied both to space flight and to terrestrial needs.

--Twenty-nine NASA science experiments were flown on the September Soviet Biosat mission

--Progress was made in feasibility discussions on the proposed flight of the U.S. Total Ozone Mapping Spectrometer on a Soviet Meteor-3 meteorological satellite and the flight of a French receiver to support Mars surface measurements planned for the Soviet Mars '94 mission.

--The Soviets selected two U.S. instruments for flight on the Soviet Spectrum-X astrophysics mission, and NASA accepted, in principle, a Soviet proposal to fly the gamma-ray burst instrument KONUS on the U.S. WIND spacecraft scheduled for launch in 1992.

o Planning accelerated in 1989 for NASA's Earth Observing System (EOS), the cornerstone of the Mission to Planet Earth. A group of 41 instruments from the U.S., Canada, Japan and Europe was selected this year for flight on EOS and over 500 scientists from 13 countries, from as far away as China, Australia and Brazil, have been identified to participate in the EOS program.

o In February, NASA convened a panel of experts on Earth science and technology, which met in Abingdon, England, and generated 10 projects in the Earth sciences which will be implemented internationally in observance of International Space Year (ISY) in 1992.

COMMERCIAL PROGRAMS

Significant progress was made in 1989 by NASA's Office of Commercial Programs (OCP) in defining an overall program of commercial space development.

The Commercial Programs Advisory Committee (CPAC) conducted a thorough review of commercial space issues and formulated a series of key recommendations for consideration by the nation's leaders. These recommendations, addressed in the CPAC's first formal report entitled "Charting the Course: U.S. Space Enterprise and Space Industrial Competitiveness," are helping to shape the commercial development strategy.

Also supporting the OCP strategic planning effort was a study conducted by the American Institute of Aeronautics and Astronautics (AIAA) to lay groundwork for the strategic plan by defining issues and potential objectives associated with the commercial development of space. The AIAA formed a steering committee consisting of senior level private sector managers.

The resulting study document, "Issues in Strategic Planning for Commercial Space Growth," representing inputs from more than 90 industry representatives, addresses overall goals and objectives, the scope of commercial space activities and the role industry, academia and government, explores issues and barriers and suggests federal actions and policy changes.

A resurgence of industrial research and development activity took place this year following the successful return of the Space Shuttle to flight operations in 1988. In 1989, the OCP sponsored commercial development payloads on three Shuttle missions and funded the first U.S. commercial launch of a materials science payload. Commercial experiments flown on the Shuttle included:

*Protein Crystal Growth, an experiment package flown by the NASA-sponsored Center for Macromolecular Crystallography located at the University of Alabama in Birmingham, was carried aboard STS-29 in March. The experiment, conducted in collaboration with industrial partners, also will be flown on STS-32.

*Fluids Experiment Apparatus, flown on STS-30, is scheduled to fly on STS-32. The FEA, a modular microgravity chemistry and physics laboratory, is being flown under a NASA-Rockwell International Corp. joint endeavor agreement (JEA) in the field of floating zone crystal growth and purification research.

*Polymer Morphology, a 3M-developed organic materials processing experiment, was designed to explore the effects of microgravity on polymeric materials as they are processed in space. The experiment, conducted on STS-34 in October, was 3M's fifth space experiment and the first under the company's 10-year JEA with NASA for 62 flight experiment opportunities.

In an effort to match space transporation and support capability with the anticipated growth in industry requirements, NASA in 1989 initiated a grant funding for a commercial sounding rocket program. Consort 1, a package of materials science investigations launched successfully on March 29 atop the commercially provided Starfire rocket at White Sands Missile Range, N.M., was the first flight conducted under this effort.

Consort 2, launched Nov. 15 at White Sands, was only a partial success due to a malfunction in the rocket's guidance package, resulting in termination of the mission as the rocket strayed off course. However, the experiments payload parachuted safely to Earth and suffered only minor damage. Important payload data was recorded during the brief flight and indicated that the experiment equipment performed flawlessly. The payload will be launched again at a later date.

Other key OCP activities in 1989 included:

*Announcement of new digital, visual-filtering technology, developed by a researcher at NASA's Jet Propulsion Laboratory (JPL), Pasadena, Calif., to aid sufferers (mostly elderly) from maculopathy or central spot blindness. Visualtek, Inc., Santa Monica, Calif., is collaborating with JPL to market an effective, inexpensive commercial product by the end of 1991.

*Introduction of an implantable, rechargeable physiologic sensor to monitor glucose marked a major advance for insulin-dependent diabetics. The sensor is now being developed in a collaborative effort among the Johns Hopkins University Applied Physics Laboratory, Laurel, Md.; the University of New Mexico, Albuquerque; and NASA's Goddard Space Flight Center.

*The collaboration of the Center for Commercial Development of Space Power, Auburn University, Ala., and Maxwell Laboratories, San Diego, to develop a stronger, more efficient power supply for lasers, x-rays, spacecraft and other users. The advance, which will result in commercial uses of the technology on Earth, represents the first technology spinoff from NASA/industry-supported research at NASA's 16 Centers for Commercial Development of Space.

*NASA's Ames Research Center, Mountain View, Calif.; Genentech Inc., South San Francisco, Calif.; and Penn State's Center for Cell Research, announced collaboration on a ground-based and Space Shuttle experiment program to increase medical knowledge to treat human bone diseases, organ regeneration and transplantation, and immune and skeletal muscle cell definiciency.

The Small Business Innovation Research Division awarded 248 Phase I and 84 Phase 2 contracts to small, high technology firms. Additional Phase 2 selections, to be made in early 1990, are expected to bring the total number of selections to more than 100 and the total procurement value to more than $50 million.

EDUCATIONAL AFFAIRS

The first 17 Designated Space Grant Colleges/Consortia were selected on Aug. 31, 1989, initiating NASA's National Space Grant College and Fellowship Program. These designated colleges/consortia, already significantly involved in space-related activities, will receive up to $225,000 in grants and $100,000 in fellowships, beginning in Fiscal Year 1990 for 5 years. The program is designed to create a network of universities capable of contributing to aerospace science and technology and training a highly skilled workforce.

President Bush selected "Endeavour" as the name for the replacement Space Shuttle orbiter on March 20, 1989. The name resulted from a nationwide competition supported by educational projects created by student teams in elementary and secondary schools. Over 6,100 entries, involving over 71,000 students, were evaluated. The national winner in the kindergarden-6th grade division was the 5th-grade class from Senatobia Middle School, Miss. The national winner in the 7th-12th grade division was a team from the Tallulah Falls School, Inc., Ga.

NASA announced the opportunity for educators to participate in the first experiment ever to study the effects of long-term space exposure on living tissue. With the return of the Long Duration Exposure Facility, deployed in Earth orbit in April 1984, 12.5 million tomato seeds, packaged in kits, will be available to teachers in grades 5 through university. The program encourages student involvement by providing them the opportunity to design their own experiments and make decisions, gather data and report final results to NASA by June 15, 1990.

Through a pilot program, NASA Marshall Space Flight Center, Huntsville, Ala., has opened its computerized science data bases to the nation's universities to stimulate "cottage industry" space research by professors and entice more students into science and engineering studies. The Joint Venture (JOVE) Program, makes NASA's scientific and engineering data, generated from space missions, available to universities in exchange for analysis and interpretation by faculty members and students.

Three student experiments, selected under the Space Shuttle Student Involvement Program, flew aboard the Space Shuttle in 1989. On STS-29, student investigator John Vellinger, Lafayette, Ind., flew 32 chicken eggs to determine whether a chicken embyo can develop normally in a weightless environment. Also flown on STS-29 was an experiment designed by Andrew Fras, Binghamton, N.Y., to determine whether rat bone healing is impeded by the loss of calcium and the absence of weight-bearing during space flight.

An ice crystal experiment was flown on STS-34 to observe geometric ice crystal shapes formed at supercooled temperatures without the influence of gravity. Proposed by Tracy Peters, Concord, Calif., the experiment results could aid in the design of radiator cooling and cryogenic systems and in understanding of high altitude meteorology and planetary ring structure theories.

In its 8th year, the Space Science Student Involvement Program selected eight national winners in the Space Station category. Top honors, plus a $3,000 scholarship and a computer, went to Diane Fogel, Landsdale, Pa., for her proposed experiment to test remedies for bone loss during space flight. Also honored were the winners of the student newpaper competition, Allen Chen, Columbus, Ind., and Paul Schumacher, Yuma, Ariz., and a team of Mechanicsburg, Pa., students who won a pilot project to design and plan the first permanent manned Mars colony.

The Aerospace Education Services Project continues to be one of NASA's most popular education programs. During 1989, over 1.2 million students and 28,000 teachers participated in school visits, classroom lectures and teacher workshops conducted by the NASA project.

During the summer, educators spent 2 weeks at one of NASA's nine field centers learning the latest in aerospace science, working with educational specialists to fit materials into classroom curriculum. There were 115 elementary school teachers participating in NASA's Educational Workshop for Elementary School Teachers and 100 teachers participating in NASA's Educational Workshops for High School Math and Science Teachers.

Over 20,000 educators in the 50 states and parts of Canada tuned in for NASA's satellite video conferences. NASA projects covered in the live, interactive program this year included planetary exploration, flight testing, future explorations and technology for the classroom.

Over $8 million was awarded to 496 students at 110 universities for advanced study in engineering and space, physical, life and environmental sciences under NASA's Graduate Student Researcher's Program, including the Under-represented Minority Focus component.

In the University Advanced Design Program, 36 universities received 3-year grants to study topics in space and aeronautical missions in the post-Space Station era, such as manned Mars aircraft and delivery systems, long-term space habitat, lunar launch and landing facilities and high-speed civil transport. The grants are $32,000 per year for each new participant and $20,000 per year for each school participating in the previous design program.

- end -

NASA News

National Aeronautics and
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Washington, D.C. 20546
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NASA DESIGNATES 4 ADDITIONAL SPACE GRANT COLLEGES/CONSORTIA

NASA today announced the selection of four additional universities and consortia as Designated Space Grant Colleges/Consortia in the National Space Grant College and Fellowship Program, bringing the total to 21.

NASA Administrator Richard H. Truly said, "As a result of Congress appropriating additional funds to expand the Space Grant Program, NASA is now able to designate the remaining 4 qualified consortia from the original competition. I strongly believe the investment in these four new consortia will broaden geographic representation and nourish the growing aerospace education programs of the nation. In light of the President's recently announced space exploration initiative, this program will be key to attracting and developing future generations of the most talented engineers and space scientists."

The four newly designated universities and consortia, listed in alphabetical order, are: University of Hawaii at Manoa, Iowa Space Grant College Consortium, New Mexico Space Grant Consortium, and Tennessee Valley Aerospace Consortium.

In fiscal year 1990, the 21 designated Space Grant Colleges/Consortia each will receive up to $225,000 per year, for at least 5 years, and are expected to obtain, as a minimum, matching non-federal funds. In addition, these designated institutions will receive $100,000 funding from NASA to support fellowships for undergraduate and graduate students.

The selection of the first 17 universities and consortia as Designated Space Grant Colleges/Consortia was announced Aug. 31, 1989. Selection was based on a competitive evaluation of the institutions' existing aerospace activities as well as the quality of their plans to strengthen the national educational base for science, math and technology.

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Designated Space Grant Colleges/Consortia will provide leadership and form partnerships with other universities, government and industry to better understand, develop and use space resources through research, education and public service functions.

The National Space Grant College and Fellowship Program comprises three elements: (1) designation of Space Grant Colleges/Consortia which will provide for a national network of universities and colleges; (2) awards to support space grant programs at other institutions that will expand participation of colleges/universities/consortia that have not been as extensively involved in aeronautics and space research and education; and (3) space grant fellowships that will be made available to students at institutions selected in the first two elements. The first of the elements is the subject of this announcement. The second and third elements of the National Space Grant College and Fellowship Program will be initiated in fiscal year 1990.

A complete list of Space Grant institutions can be obtained by phoning the NASA Headquarters Newsroom on 202/453-8400.

- end -

NASA News

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RELEASE: 89-185

NASA TO COMBINE EXPLORATION AND TECHNOLOGY ORGANIZATIONS

Richard H. Truly, NASA Administrator, announced today that he intends to merge two major agency offices to insure tight coordination in the creation of plans for human exploration of the solar system and the actual development of new technologies required to accomplish the goal.

The organizations involved are the Office of Aeronautics and Space Technology and the Office of Exploration.

Truly said that the Office of Exploration, under the direction of Dr. Franklin D. Martin, Assistant Administrator, had successfully completed the preliminary studies of requirements to undertake sustained human exploration of the solar system. Last July 20, President Bush announced that it would be a goal of the United States to establish a permanent human presence on the Moon and use the experience gained there to begin exploration of the planet Mars.

"The time has come now not only to continue our analysis of exploration mission alternatives but also to begin actual pursuit of the innovative and enabling technologies that have been identified as necessary to proceed," Truly said. "These two efforts are closely related and we want them to advance virtually in lock step under a strong central management."

The heads of the two offices - Arnold D. Aldrich, Associate Administrator for Aeronautics and Space Technology, and Dr. Martin - have been asked to prepare the consolidation plan during the early weeks of next year. The new organization will be headed by Aldrich.

The Office of Exploration was created 2-1/2 years ago on the recommendation of Dr. Sally K. Ride, a physicist and the first American woman to fly in space. Ride had directed a study to help determine the nation's next major goal in space.

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The study group recommended that the country undertake one or more of four activities - expanded robotic study of the solar system, considerably stepped-up investigation of Earth processes to better protect the environment, establishment of a scientific outpost on the Moon and human exploration of Mars.

The study recommended that NASA create a "think-tank" office to do the preliminary studies in human exploration. This included identification of new technology required, as well as new space transportation capabilities.

In the past, American private enterprise has been able to translate new space technology into products and processes that helped the nation maintain a lead in world markets and insure economic well-being at home.

It is anticipated that technology to be developed over the next two decades for solar system exploration will lead to advances in the private economy in artificial intelligence, robotics, telepresence and teleoperation, process automation, low-cost global and orbital transport, optical communication and data processing systems, supercomputers, wireless power transmission, closed-ecology biosphere operation, ultra high-strength, high-temperature and light weight materials and many others.

The development of innovative technology has been a responsibility of the Office of Aeronautics and Space Technology for a number of years. That office already is engaged in cooperative projects with the Department of Defense to develop advanced Earth-to-orbit transportation systems. One is the National Aero-Space Plane which will take off from a runway, fly to orbit and land like a conventional plane.

Truly emphasized that the merger of the two offices would not diminish the agency's strong devotion to aeronautical research. "NASA evolved from the nation's original aeronautical research organization, the National Advisory Committee for Aeronautics, and has worked on the cutting edge of aeronautics since its inception," he said. "Perhaps nothing we have done has benefitted the country economically as much as this research. Because of it, the U.S. aerospace industry has been able to maintain an unqualified lead in world markets."

During the merger process, particular attention will be paid to the institutional aspects of the new organization to insure that it will have the personnel, equipment and facilities needed to carry out its new missions successfully, Truly said.

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"The Office of Exploration has done a superlative job in helping the nation prepare to move into the next century in space," Truly said. "Now it is time to merge this first rate creative organization into the technology development mainstream. This move coincides exactly with the onset of the next phase of the solar system exploration effort which emphasizes technology development."

"Later, in the 1990s, Space Station Freedom will be in place and functioning and our technology programs will be well down the road. Primary attention will be shifting to the lunar and Mars efforts. In the interim, we will have time to evaluate the effectiveness of this new management structure resulting from this merger and to consider future changes to insure its creativeness and efficiency when we reach the intense period immediately preceeding our return to the Moon," Truly said.

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NASA News

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PIONEERS MAKE FIRST MEASUREMENTS OF INTERSTELLAR LIGHT

Using extensive light measurements made by the Pioneer 10 and 11 spacecraft, a NASA scientist has produced "celestial constants" that will be highly useful to astronomers and physicists. The new constants are the first "pure" measurements of the various kinds of background light in our solar system, galaxy and universe.

Work conducted by Dr. Gary Toller, Goddard Space Flight Center, Greenbelt, Md., and General Sciences Corp., Laurel, Md., indicates that background light from beyond the solar system is made up of approximately 82 percent light from faint stars. Most of the remainder is galactic light diffused by dust; the final proportion, less than 0.6 percent of background light, originates beyond the galaxy.

Since much of the knowledge of the universe comes from visible light, the data will provide a benchmark in many fields of astronomy and physics. The Pioneer 10 and 11 photo-polarimeter measurements have provided the first observations of incoming light without interference of solar system light. The Pioneers are managed by NASA's Ames Research Center, Mountain View, Calif., for the agency's Office of Space Science and Applications.

The new work, combined with other measurements, also provides a clue to chemical composition of solar, galactic and cosmic dust. It gives an accurate measure of the Sun's position above the plane of the galaxy (about 12 parsecs). It describes how cosmic dust scatters light. For the entire celestial sphere, 60 percent of light is scattered, not absorbed, predominantly in the same direction it had been travelling in.

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Toller has used his data as another way to calculate total amounts of visible matter in the universe. These calculations confirm other estimates that 90 percent of matter in the universe is "missing" or unseen dark matter.

Toller and others used a variety of observations from Earth for the analyses, combining data on the quantities of stars and types of stars with computer models of light scattering in the galaxy, amounts of dust and gas and size of particles. Then he compared these models to measurements made by the Pioneers as the two spacecraft moved out of the solar system.

The new data will help investigators study diffuse celestial light sources such as zodiacal light, which reaches Earth after being reflected by nearby dust. For an astronomer on Earth, looking in a random direction in space, 40 percent of incoming light is zodiacal light.

Once the Pioneers were beyond 300 million miles, the zodiacal light diminished to a negligible level and scientists were able to make the first pure measurements of background light from beyond the solar system in the mid-1970s. Since then, the long flight paths of the Pioneers have made it possible to make very exact measurements of this "outside" light.

Background light from beyond the solar system breaks down into integrated starlight from stars too faint to be seen by the eye, diffused galactic light reflected by dust particles in the galaxy and light coming from outside the galaxy.

Toller, who reported his work at an international conference on galactic and extragalactic background radiation in Germany earlier this year, is continuing to refine and apply the data. Dr. Jerry Weinberg of the Institute for Space Science and Technology, Gainesville, Fla., and Dr. Ana Nash, U.S. Naval Research Laboratory, Washington, D.C., also have worked on the analysis.

Both Pioneers are still returning data. Pioneer 10 has left the Solar System and is 4.4 billion miles from the Sun. Pioneer 11 has almost reached the orbit of Neptune. Both spacecraft were built by TRW Inc., Redondo Beach, Calif.

- end -

NASA News

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RELEASE: C89-m

ROCKWELL OPERATIONS CONTRACT EXTENDED

NASA's Johnson Space Center (JSC), Houston, has awarded Rockwell Space Operations Co., Houston, a 5-year extension with three 2-year options of its existing contract for Space Transportation Systems Operations (STSOC).

The modification definitizes the government's option to require the contractor to provide uninterrupted performance of the contract effort for the next 11 years.

The total estimated value of the initial extension of the cost-plus-award-fee contract, from Jan. 1, 1990 to Dec. 31, 1994, is approximately $1.549 billion, with options to extend performance through Dec. 31, 2000. Options for incremental increase of effort during the period of performance also are included. The total estimated cost of the entire extension, should all options be exercised, is approximately $4.585 billion.

Work provided under the contract includes maintenance and operations of Space Transportation Systems facilities, including the mission control center, crew trainers and simulators, flight design and crew activities planning systems, shuttle avionics integration laboratory and the portion of the central computing facility that supports STS.

Also included are flight preparation activities, including flight planning and flight data generation orbiter software reconfiguration, direct mission support by means of simulations and flight and sustaining engineering support for these activities. Contract work is performed at JSC and at Rockwell's facility near the center.

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NASA News

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RELEASE: C89-n

CONTRACT EXTENSION AWARDED TO COMPUTER SCIENCES CORPORATION

NASA's Johnson Space Center (JSC) has awarded the third year of the Mission Operations Support Contract (MOSC) to Computer Sciences Corp., Houston. The current contract expires on Dec. 31, 1989.

The estimated total cost for the third year of the five-year cost-plus-award-fee contract is $32,056,252. The original contract was awarded January 1, 1988, and provided for a one-year period of performance and four one-year options.

The MOSC contract provides for the maintenance, operations, systems engineering, and user support of institutional automated data processing (ADP) facilities, networks and workstations at the center. The work will be performed on, or near, JSC.

-end-

NASA News

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JSC SIGNS PAYLOAD INTEGRATION CONTRACT WITH ROCKWELL

NASA's Johnson Space Center (JSC) has signed a 5-year payload integration contract with Rockwell International Corp., Downey, Calif. The contract will begin Jan. 1, 1990, and extend through Dec. 31, 1994.

The value of the cost-plus-award-fee contract is $260,629,000 for 3,927,000 target man-hours. Rockwell will provide all resources necessary to perform Space Transportation Systems (STS) payload and cargo integration activities during STS operations.

Payload/cargo activities include defining, designing and implementing cargo/STS interfaces, the implementation of integration hardware and software, and installing payload/cargo, including all standard STS payload-chargeable mission kit items.

The integration effort will be completed at Rockwell's Downey facility, as well as onsite at JSC, the Marshall Space Flight Center, the Kennedy Space Center, and Stennis Space Center.

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